Chapter - VII

EFFECT OF IRRIGATION AND NITROGEN ON GROWTH AND YIELD OF *Brassica campestris* L . cv. B-54 IN THE PLAINS OF DARJEELING CONDITION .

INTRODUCTION

Owing to the hardy nature and capacity to thrieve well under poor soil moisture, mustard is generally considered as a rainfed crop. For this reason it is cultivated in winter under rainfed condition at different places in India. But erratic and limited rainfall serously limits production of mustard. (Agarwal et al 1998).

In Darjeeling district also mustard is generally considered as winter crop but during the months of winter rainfall is scarce. Moreover the soil in the region, specially in the plains, is of sandy loam having low water holding capacity. Thus irrigation is felt necessary for a higher and more stable yield under such an adverse situation. Recently such a problem has recived considerable attention in mustard improvement programme in the region.

There are reports which indicates that irrigation increased the producton of mustard (Joardar et al. 1979; Khan and Agarwal, 1985). Besides it has been noted that application of nitrogen significantly increased seed and stalk yield of mustard specially *Brassica juncea* (Prasad, 1991).

But losses of "N" from cropland after irrigatin are of concern from the stand point of fertilizer use efficiency as well as potential water pollution (Narang and Singh 1989). According to them "N" is the most important nutrient for Indian mustard in terms of its requirement, rate of application and total cost management of plant response. Some study suggest that irrigation may significantly affect N-leaching and therefore excessive irrigation should be avoided (Smika, et al 1977; Snyder et al. 1984; Snyder and Davidson, 1977, 1980).

Thus an attempt has been made to study the combined effect of irrigation and nitrogen on growth and yield attributes of *Brassica campestris* L. cv B-54 which has already been justified as the cultivar most suitable for Darjeeling district. This part of work has the objective to work out optimum rate of application of irrigation and nitrogen to show maximum productivity of the cultivar in the ecological condition of the region.

MATERIALS AND METHODS

MATERIALS

Seed of *Brassica campestris* L. cv B-54 have been used during investigation.

METHODS

Raising of the cultivar : The field was prepared after repeated ploughing. Seeds of *B.campestris* cv B-54 were sown in a seedbed and seedlings were raised in a randomised block design with thre replications in the experimental plot for research in North Bengal University, Darjeeling distrct, West Bengal, The seedlings were grown in 30 cms spacing row to row and 15 cms plant to plant in 4m x 5m plot. Seeds were sown in the first week of October in three consecutive years, 1994, 1995 and 1996.

Irrigation treatment : Maximum of six levels of irrigation treatments were adopted during the growing period of the cultivar. The rate of irrigation were as follows.

0	Level	-	No irrigation
1.	Level of irrigation	-	Ist at 30 DAS
2.	Levels of irrigation	-	Ist at 30 DAS; 2nd at 60 DAS
3.	Levels of irrigation	-	Ist at 15 DAS; 2nd at 30 DAS; 3rd at 60 DAS
4.	Levels of irrigation	-	Ist at 15 DAs; 2nd at 30 DAS; 3rd at 45 DAS; 4th at 60 DAS.
5.	Levels of irrigation	-	Ist at 12 DAS; 2nd at 20 DAS; 3rd at 30 DAS; 4th at 40 DAS and 5th at 50 DAS.
6.	Levels of irrigation	-	Ist at 10 DAS; 2nd at 20 DAS; 3rd at 30 DAS; 4th at 40 DAS; 5th at 50 DAS and 6th at 60 DAS.

The measured amount of water (10mm on each occassion) was uniformly added over the irrigated plots with sprinklers.

Nitrogen fertilizer treatment : Nitrogen fertilizer was used in the from of Urea. Maximum of seven levels of N-fertilizer treatment were adopted. The initial dose was always 30kg/ha and subsequent doses involved 20kg/ha applied according to varying interval of time and which has been represented below.

0	Level of N-fertilizer	-	No fertilizer treatment
1.	Level of N-fertilizer	-	30 kg/ha at 25 DAS
2.	Level of N-fertilizer	-	Ist 30 kg/ha at 30 DAS, 2nd 20kg/ha at 45 DAS
3.	Level of N-fertilizer	-	Ist 30 Kg/ha at 20 DAS; 2nd 20kg/ha at 35 DAS 3rd 20 kg/ha at 50 DAS
4.	Level of N-fertilizer	-	Ist 30kg/ ha at 20 DAS; 2nd 20kg/ha at 30 DAS: 3rd 20kg/ha at 40 DAS and 4th 20kg/ha at 50 DAS.
5.	Level of N-fertilizer	-	Ist 30kg/ha at 20 DAS; 2nd 20kg/ha at 30 DAS; 3rd 20kg/ha at 40 DAS; 4th 20kg/ha at 50DAS and 5th 20kg/ha at 60 DAS.
6.	Level of N-fertilizer	-	Ist 30kg/ha at 10 DAS; 2nd 20kg/ha at 20 DAS; 3rd 20kg/ha at 30 DAS; 4th 20kg/ha at 40 DAS; 5th 20kg/ha at 50 DAS and 6th 20kg/ha at 60 DAS.
7.	Level of N-fertilizer	-	Ist 30kg/ha at 10 DAS; 2nd 20kg/ha at 20 DAS; 3rd 20kg/ha at 27 DAS; 4th 20kg/ha at 35 DAS; 5th 20kg/ha at 42 DAS; 6th 20kg/ha at 50 DAS and 7th 2kg/ha at 60 DAS.

Selecton of Characters : The following characters were taken into consideration during investiagation. Each value expressed in various table for different characters represent the mean of ten readings.

Plant height : The hight of the plant was measured in centemeter scale.

Number of primary branches : Number of primary branches were counted for each of the plants.

Number of secondary branches : Number of secondary branches were counted for each of the plants.

Number of siliquae/plant : Total number of total silique / plant were counted.

Number of seeds/siliqua : Total number of seeds / siliqua were counted.

Seed yield / ha : Weight of seeds produced per hectre was measured.

RESULTS AND DISCUSSION

Brassica campestris L.cv-B-54 has been observed to be the best to show growth performance out of twelve different cultivars of *B.juncea* and *B.campestris* *so far released for their commercial utilisation in West bengal and which has so* far not been studied in the plains of Darjeeling condition. This has been worked out on the basis of their relative adaptibility to the environmental condition of the district and also on their resistant behaviour against *Lipaphis erysimi* Kalt, an aphid, seriously damaging the crop not only in West Bengal but also through out India. The result on their observations have been represented elsewhere in the thesis. Though *B.juncea* cv. RW-85-89 and *B.juncea* cv. Sharma 85-89 showed adaptibility more or less similar to that of *B.campestris* L.B-54, the most remarkably important characteristic feature of cv. B-54 is that of its early flowering capacity in Darjeeling condition (Table -7). It is expected therefore that ther is possibility for cv-B-54 to be harvested more than once during winter months in the region. Yagodin (1984) observed that in order to create favourable conditions for the growth of winter crops, nitrogen fertilizers must be applied before seeding. He also suggested that to increase the yields of winter crops, it was extremely important to dress them with nitrogen fertilizers in early spring. Treatment with nitrogen generally enhances the growth of vegetative organs, formation of flower buds and ovaries, the size of fruits and their quality. According to him most of the incorporated fertilizer nitrogen is lost from the soil in gaseous form (N_2 and N_2O) after denitrification. The gaseous nitrogen losses are more pronounced from nitrates as opposed to ammonia fertilizers and urea. To minimize nitrogen losses and to enhance the effectiveness of nitrogen fertilizers it is extremtly important to apply them at the right time, at optimal rates, crop rotations and proper irrigation.

It is well established that mustard plants are rainfed crops and thrieve well in winter months. Besides it is observed by a number of authors that proper water use and N fertilization increased productivity of mustard crops (Prasad 1991; Joarder et al, 1979; Khan and Agarwal, 1985).

In order to observe the growth of various parameters related to yield components of *B.campestris* cv. B-54 under the rainfed condition in the plains of Darjeeling district much emphasis has been given on these aspects.

Table-25 shows that seed yield per hectare by this cultivar is only 4.7g/ha; though average plant height has been observed to be 67.4cms. Number of primary and secondary branches are only 3.8 and 6.2 respectively. Number of siliquae/plant has been observed to become 74.1 and number of seeds are 6.4 pr siliqua.

The result suggest that the cultivar does not perform well under naturally available rainfed condition of Darjeeling district. It is expected that during the period of experimentatin in the winter months of Darjeeling plains; the rainfall was appreciably low as represented in meteriological data (Table-24).

This was also observed by various other authors performing the same type of experiments dealing with various sprcies of *Brassica juncea* (Sharma and Kumar 1991), on silty clay loam soil at Pant Nagar, Himachal Pradesh and *B.napus* on sandy loam at Hissar (Singh et al, 1990).

These authors were of the opinion that low yield of all the *Brassica* sps. grown under rainfed condition at different places were due to low rainfall accompanied by low water holding capacity of the soil. That water use by the crops depend on their developmental stage and meteriological conditions was pointed out by Prihar and Sandhu (1987).

The data on the analysis of soil of experimental plot which is situated at the foot hills of eastern Himalaya has been represented in the Table-32. Though the surface layer of the soil was sandy loam in texture the lower strata were very much sandy and having with low water holding capacity. This is similar to the observation worked out by Govinda Rajan and Gopal Rao (1978). According to them the soil in the plains of Darjeeling district are found by the downward movement of materials from the lower Himalayan range through soil erosion and depositin in a broad stip along the foot hills areas. The surface soil posess a sandy loam or silty loam texture. The lower strata are formed of stones and gravel of miscellaneous rocks, though occasionally they appear at the surface also. This layer makes the soils permeable and with adequate drainage, the soils become highly productive as these are naturally fertile.

Thus low yield and yield attributes of *B.campestris* cv. B-54 trialed under rainfed condition of Darjeeling district was due to low rainfall during the period of treatment at the same time low water holding capacity of sandy soil.

Moteroligical data related the period of investigation has been represented in the table No.16 (Chapter-III).

Soil sample was analysed in collaboration with Indo-British. Fertilizer Education Project (Hindusthan Fertilizer Corporation Ltd.) Soil testing laboratory Siliguri following the method described by Black (1965) and has been represented in the table No.32.

Beneficial effect of rainfed condition on growth and yield attributes of *B napus* L. during winter was observed by Choudhury et al (1990) at Jorhat, Assam, According to them soil was rich in organic carbon (0.86%) Rainfall was normally received during the period and as such application of irrigation in rape seed was not expected to give response. Highest water use efficiency was under rainfed treatment during all the years of experimentation. They also pointed out this was due to low water requirement of the crop resulting from low water use of natural rainfall.

Sharma and Thakur (1993) conducted 2 years field experiment during the winter season indicated that sowing Argentine rape (*Brassica napus* L.) under rainfed condition in October considerably increased productivity in mid hills of North Western Himalayas. The increase in seed yield on October sown crop was attributed to early emergence and rapid growth due to relatively warmer temperature in October (16.1^{0}C) as against November (13.1^{0}C) sown crops.

Krogman and Hobbs (1975) considered the *B. campertris* shoud be regarded as irrigated crop. Thus in order to avoid water strees investigation was conducted to observe the effect of six levels of irrigation on yield and yield attributes *B. camperstis* of Darjeeling condition.

Table-26 shows that increase in levels of irrigation have been observed to increase seed yield per hectare, though four levels of irrigation has been observed to be optimum to show maximum seed yield (7.3q/ha), number of siliquae per plant (90.6) and number of seeds per siliqua (9.1) as against control value under no irrigation showing the result of 4.7 q/ha, 74.1 and 6.4 respectively.

Thus increase in levels of irrigation shows increase of all the values of plant height, number of primary branches and number of secondary branches in *B. campestris* cv. B-54 grown in the winter months of Darjeeling district, West Bengal.

That irrigation has a great effect upon seed yield of rape under dry growing condition was observed by various authors. (Krogman and Hobbs 1975). Joarder et al (1979) also observed 60% more yield of mustard seed per ha and per plant by the use of irrigation. They noted higher seed yields in irrigated plots accompained by increased pod/plant, seed/pod, seed yield/plant and number of primary and secondary branches in *B. juncea* in Bangladesh condition.

The most significant increase (83%) was noted in the number of seeds per pod produced by late flowers under irrigation, whereas the increase for early formed pod was only 6%. Increase of more than 20% for primary and secondary branches and pods/plant were also obtained with irrigation, but there were no significant differences in 1000 seed weights of early and late flowered pods though the seeds of irrigated plants were slightly heavier than in non irrigated ones. Under irrigated conditions plants produced more primary and secondary branches, more late flowers produced seed bearing pods, more embryos in each pod developed into seeds and seeds grew slightly larger than without irrigation indicating importance of irrigation in mustard cultivation. According to Joarder (1979) *B. juncea* should be regarded as irrigated crop.

In order to avoid water stress Sharma and Kumar (1991) utilised two irrigations at 29 and 45 DAS for goods growth of *B. juncea* at the Govind Ballabh Pant University of Agriculture and technology, Panthnagar on Silty clay loam soil.

In connection with field experiment conducted during winter at Hisar Singh et al (1990) applied five irrigation treatments for rape seed. *B. napus* growing in sandy loam soil (65.8% sand, 16-5% silt and 17.7% clay). In general irrigation increased the reserve soil moisture content, which improved the water status and growth of the plant. According to them higher rate of water flow from the soil via plant to atmosphere due to less stomatal resistance and more leaf area which helped to sustain better transpiration rate in repeseed, improved the siliquae bearing in the crop and hence the yield. Highest production of seed yield / ha was observed with 2 irrigations.

Among the fertilizer nitrogen has been found to play greater role in increasing the yield of *Brassica* crops and a number of workers in India and abroad has shown significant increase of seed and stalk yield of mustard (Maini et al, 1959; Allen and Morgan 1972; Sen et al, 1977 Murtaza and paul 1989, Sain et al 1977; Prasad, 1991.

The Table-32 Shows that soil in the plains of Darjeeling district has low content of organic nitrogen. Thus investigation was conducted to study the growth and yield attributes of *B.campestris* cv. B-54 with increasing application of nitrogen. But losses of 'N' from corp land after irrigation are of concern from the stand point of fertilizer use efficiency and it is established that irrigation siĝnificantly affect N-leacing and therefore excessive irrigation should be avoided (Smika et al, 1977; Snyder et at, 1984; Prasad, 1991).

Thus here in this part of work different levels of irrigation and nitrogen have been applied to understand their combied effect on the growth of *B.campestris* cv. B-54 in Darjeeling condition. In this connection six levels of irrigation and seven levels of nitrogen fertilizer were applied at different DAS.

Table -27 shows the result after the application of 1 level of irrigation and 4 levels of nitrogen. All the parameters of plant height, number of primary and secondary branches, number of siliquae per plant, number of seeds per siliqua and seed yield per hectre have been observed to be increased with the increase in amount of N fertilizer upto the limit of three levels i.e. 30 kg/ha at 20 DAS; 20kg/ha at 35 DAS and 20 kg/ha at 50 DAS. Further increase of N fertilizer has been observed to show decreased values of all the parameters and browinng of leaves has been observed to show accelerated senescence due to salt strees caused by over dose of N-fertilization with limited application of one irrigation at 30 DAS and low rainfall during the period of treatment.

Table-28 shows that during the treatment of 2 levels of irrigation (at 30 DAS and 60 DAS) and 5 levels of N-fertilization maximum values for more or less all the parametre have been observed upto the limit of 4 levels of N application. Seed yield/ ha has been observed to be 14.90 q/ha. Characteristic sign of growing of plants due to salt strese has also been observed after application of fifth level N-fertilizer. This has also been associated withlowered values of seed yield and yield attributes.

Observations in connection with the treatment of 3 levels of irrigations (at 15 DAS, 30 DAS and 60 DAS) and 6 levels of N. applicatin have been represented in the Table-29. Here also 4 levels of N-application (30 kg/ha at 20 DAS, 20 kg/ha at 30 DAS 20 kg/ ha at 40 DAS and 20 kg/ha at 50 DAS) have shown promising result. Number of siliquae/plant, seeds/siliqua and seed yield per hactare have been ovserved to show maximum values of 176.6, 16.40 and 5.20 q/ha respectively, though the values in connection with plant height, number of primary and secondary branches have been observed to be increased due to further application of 5 and 6 levels of nitrogen fertilizer. Growing of plants have developed after application of 4 levels of N-fertilizer.

During the treatment of 4 levels of irrigation (at 15 DAS, 30 DAS, 45 and 60 DAS) and maximum of 6 levels of N-fertilization, increased values for all the parameters have also been observed with the increase of fertilizer levls (Table 30). Maximum of 16.00 q/ha of seed yield has been recorded due to these combinations of treatment. Application of 5 levels (Table-31) of irrigation (at 12 DAS; 20 DAS; 30 DAS; 40 DAS and 60 DAS) in combination with 5 levels of N-fertilizer (30 kg at 15 DAS; 20 kg at 25 DAS; 20 kg at 35 DAS, 20 kg at 45 DAS and 20 kg at 55 DAS) shows the best performance of seed yield 916.60 q/ha) number of siliquae/ plant (210-0) and number of seeds/ siliqua (18.40). Maximum of 135.1cm of plant height has been observed at the end of the application of 7 levels of N-fertilizer though maximum values of 9.5 and 20.2 for number of primary and secondary branches respectively have been recorded after the treatment of 6 levels of N-fertilization. (Table-31).

Thus out of all the combination of treatments for irrigation and N-fertilization as represented in table 25 and 31 application of 5 levels of irrigation and 5 levels of N-fertilizer (Table-31) may be recommended for cultivation of *B. campestris* L. cv. B-54 in the plains of Darjeeling district for its commercial utilisation.

Table - 25

Yield and yield component of *B. campestris* L. cv. B-54 grown under rainfed condition without the application of irrigation and nitrogen fertilizer in the plains of Darjeeling districts, West Bengal.

	Plant height (cm)	No. of Primary branches	No. of Secondary branches	No. of siliquae/ plant	No. of seeds/ siliqua	Seed yield/ ha. (q)
Mean :	67.4	3.47	6.2	74.13	6.4	4.76
S.E. :	0.12	0.06	0.13	0.18	0.15	0.9
C.D. at 5% level :	0.50	0.25	0.57	0.76	0.64	0.37
C.D. at 1% level :	1.15	0.57	1.32	1.92	1.49	0.86

Table - 26

Effect of irrigation with the application of irrigaton and nitrogen fertilizer treatment at different level on yield and yield components of *B. campestris* L. cv. B-54 grown in the plains of Darjeeling district, West Bengal.

Levels of irrigation	Plant height (cm)	No. of Primary branches	No. of Secondary branches	No. of siliquae/ plant	No. of seeds/ siliqua	Seed yield/ ha. (q)
0	67.4	3.8	6.2	74.1	6.4	4.7
1	74.2	4.3	7.4	82.1	7.3	5.2
2.	81.5	4.9	8.2	89.2	8.1	6.4
3	93.6	5.3	9.2	90.1	8.9	7.1
4	102.2	5.9	10.1	90.6	9.1	7.3
5	112.4	6.8	11.8	88.1	8.1	6.9
6	116.7	6.5	11.2	80.2	7.7	6.1
Mean :	92.57	5.36	9.16	84.92	7.94	6.25
S.E. :	7.75	0.45	0.83	2.55	0.38	0.40
C.D. at 5% level :	19.93	1.17	2.13	6.56	0.98	1.02
C.D. at 1% level :	31.26	1.83	3.34	10.29	1.53	1.53

Table - 27

Effect of combined treatment of irrigation (1 level) and split doses of nitrogen on yield and yield components of *B. campestris* L. cv. B-54 grown in the plains of Darjeelig district, West Bengal.

Treatment N-rates (kg/ha)	Time of applic-ation (DAS)	Plant height (cm)	No. of primary branches	No. of second-any branches	No. of siliquae/ plant	No. of seeds/ siliquae (q)	Seed yield ha (q)
0	0	74.22	43	7.4	82.1	7.3	52
30	25	106.0	6.5	11.9	143.3	10.2	9.20
30 20	30 45	110.2	7.1	12.5	156.8	12.31	11.57
30 20 20	20 35 50	114.4	8.4	13.7	166.7	14.4	12.90
30 20 20 20	20 30 40 50	107.5	7.9	12.1	139.9	9.8	8.90
Mean :		102.46	6.84	11.52	137.76	10.8	9.55
S.E. :		7.20	0.71	1.08	14.72	1.20	1.32
C.D. at 5% Level:		20.00	1.98	2.99	40.86	3.34	3.66
C.D. at 1% Level :		33.17	3.29	4.96	67.76	5.54	6.07

Table - 28

Effect of combined treatment of irrigation (2 levels) and split doses of nitrogen on yield and yield components of *B. campestris* L. cv. B-54 grown in the plains of Darjeeling district, West Bengal.

Treatment N-rates (kg/ha)	Time of applic-ation (DAS)	Plant height (cm)	No. of primary branches	No. of second-any branches	No. of siliquae/ plant	No. of seeds/ siliquae (ql)	Seed yield ha (ql)
0	0	81.5	4.9	8.2	89.2	81.0	6.3
30	25	108.0	7.0	13.9	158.0	11.95	12.00
30 20	25 40	111.2	7.4	14.3	162.4	12.95	12.84
30 20 20	25 40 50	116.3	8.4	14.6	170.2	14.90	13.30
30 20 20 20	20 30 40 50	118.0	8.9	16.2	174.1	15.40	14.90
30 20 20 20 20	20 30 40 50 60	119.0	8.9	16.4	170.1	14.20	13.20
Mean :		109.0	7.58	13.93	154.0	12.92	12.09
S.E. :		6.31	0.68	1.34	14.44	1.20	1.34
C.D. at 5% Level :		17.50	1.90	3.71	40.07	3.33	3.71
C.D. at 1% Level :		29.03	3.15	6.16	66.46	5.52	6.15

Table - 29

Effect of combined treatment of irrigation (3 levels) and split doses of nitrogen on yield and yield components of *B. campestris* L. cv. B-54 grown in the plain of Darjeeling district, West Bengal.

Treatment N-rates (kg/ha)	Time of applic-ation (DAS)	Plant height (cm)	No. of primary branches	No. of second-any branches	No. of siliquae/ plant	No. of seeds/ siliquae (q)	Seed yield ha (q)
0	0	93.6	5.3	9.2	90.1	8.9	7.1
30	25	107.2	6.9	12.1	144.4	10.6	9.60
30 20	20 40	113.2	7.8	14.9	166.4	13.20	13.12
30 20 20	20 40 50	117.7	8.7	15.2	172.3	15.10	13.90
30 20 20 20	20 30 40 50	120.2	9.1	16.8	176.6	16.40	15.20
30 20 20 20 20	15 25 35 45 55	122.2	9.3	16.9	172.2	15.80	14.95
30 20 20 20 20 20	10 20 30 40 50 60	125.4	9.6	14.1	164.3	14.20	12.10
Mean :		114.21	8.1	14.17	135.14	13.46	12.28
S.E. :		4.12	9.59	1.04	11.56	1.05	1.12
C.D. at 5% level :		10.07	2.53	2.53	28.27	2.57	2.75
C.D. at 1% level :		15.26	3.84	3.84	42.83	3.90	4.16

Table - 30

Effect of combined treatment of irrigation (4 levels) and split doses of nitrogen on yield and yield components of *B. campestris* L. cv. B-54 grown in the plain of Darjeeling district, West Bengal.

Treatment N-rates (kg/ha)	Time of application (DAS)	Plant height (cm)	No. of primary branches	No. of secondany branches	No. of siliquae/ plant	No. of seeds/ siliquae (q)	Seed yield ha (q)
0	0	102.2	5.9	10.1	90.6	9.1	7.3
30	25	109.4	7.2	12.7	149.3	11.8	10.80
30 20	20 40	114.2	8.1	15.0	168.2	13.40	13.95
30 20 20	20 40 50	120.3	8.9	16.9	172.8	16.50	14.20
30 20 20 20	20 30 40 50	123.4	9.3	17.2	182.4	17.40	15.30
30 20 20 20 20	15 25 35 45 45	127.5	9.4	18.1	190.1	18.00	15.90
30 20 20 20 20 20	10 20 30 40 50 60	130.2	9.4	19.4	190.2	18.10	16.00
Mean :		118.17	8.31	15.63	163.37	14.90	13.35
S.E. :		3.81	0.52	1.23	13.27	1.33	1.21
C.D. at 5% level :		9.33	1.24	3.02	32.48	3.26	2.96
C.D. at 1% level :		14.14	1.88	4.57	49.21	4.93	4.48

Table - 31

Effect of combined treatment of irrigation (5 levels) and split does of nitrogen on yield and yield components of *B. campestris* L. cv. B-54 grown in the plain of Darjeeling district, West Bengal.

Treatment N-rates (kg/ha)	Time of applic-ation (DAS)	Plant height (cm)	No. of primary branches	No. of second-any branches	No. of siliquae/ plant	No. of seeds/ siliquae (q)	Seed yield ha (q)
0	0	112.4	6.8	11.8	88.1	8.1	6.9
30	25	116.6	7.6	13.4	128.6	10.1	8.90
30 20	20 40	112.7	8.6	14.8	142.7	11.9	10.20
30 20 20	20 40 50	1162	8.9	15.2	169.2	14.20	11.20
30 20 20 20	20 30 40 50	124.7	9.4	17.6	187.4	18.10	15.90
30 20 20 20 20	15 25 35 45 55	134.2	9.5	20.1	220.0	18.40	16.60
30 20 20 20 20 20	10 20 30 40 50 60	134.2	9.6	20.2	198.8	18.20	16.10
30 20 20 20 20 20 20	10 20 27 35 42 50 60	135.1	9.5	19.1	190.1	18.00	16.00
Mean :		123.26	8.74	16.53	165.61	14.63	12.73
S.E. :		3.55	0.36	1.12	15.27	1.47	1.36
C.D. at 5% level :		8.19	0.84	2.59	35.20	3.39	3.15
C.D. at 1% level :		11.91	1.22	3.77	51.22	4.93	4.58

Table - 32

Fertility Status of the Soil obtained from the experimental plot in North Bengal University Campus. Raja Rammohanpur Darjeeling District North Bengal.

Soil Characteristics	Value	Rating
Soil pH	5.7	A
T.S.S. (M.mhos/cm)	0.13	N
Organic Carbon (%)	0.31	L
Total Nitrogen (%)	0.19	L
Carbob-nitrogen ratio	1.63	ML
Availated-phorphorus (Kg/ha)	22.50	ML
Available potassium	92.00	VL
Copper (ppm)	31.	N
Iron (ppm)	50.8	N
Maganese (ppm)	4.7	N
Zinc (ppm)	0.3	N

A=Acidic, N=Normal, L=Low, ML=Medium Low, VL=Very low.

Choudhury et al (1990) studied the effect of irrigation and nitrogen on growth and yield of *B. napus* L. during winter at Jorhat, Assam. The soil was rich in organic carbon and total N. The treatments comprised 3 irrigations schedules (rainfed, irrigation at 50% flowering i.e. 28 DAS and at early siliqua formation i.e. 38 DAS) and 4 levels of N (0,30,60), and 90 kg/ha). Irrigation at 50% flowering or at early siliqua formatin stage did not significantly change the yield attributes.

An increase in the N level increased the primary branches/ plant and grain yield of rape seed. The application of 90 kg/ N/ha produced significantly high yield. Such an increase in yield might be attributed to the corresponding improvement of yield attributing characters owing to increasing level of 'N' application. While working with the effect of 4 nitrogen levels (0,30,60 and 90 kg/ha) in combination with two irrigations at 35 and 60 DAS on mustard at Hoshangabad(MP) on clayey-loam soil, by Dubey et al, 1992, nitrogen application upto 90 kg/ha significantly increased plant height, L.A.I., number of primary and secondary branches, dry matter production/plant, chlorophyll content and grain yield. The increase at higher nitrogen levels might be due to poor availability of N-status in soil leading to better crop response. According to Singh (1987), the increase in dry matter/plant might be due to higher 'N' availability caused by two irrigations causing acelerated photosynthetic rate and thus leading to more production of carbohydrate.

While working with the response of "Pusa Bold"- mustard (*Brassica juncea* (L) CZerng and Cosson) to three levels of irrigation, and 4 nitrogen levels (0.50, 100 and 150 kg N/ha), Rama et al (1991) observed that number of siliquae and grain weight/ plant and 1000 grain weight were significantly increased with each increase in moisture availability in two years. The experiment was conducted at Baraut, Uttar Pradesh on Sandy loam soil with low nitrogen.

Here for this part of work the experimental plot situated at the foot of Darjeeling Himalayas and which is nothing but the extention of Terai region, the soil of which has been worked out in details by Govinda Rajan and Gopala Rao (1978). According to them soils in the plains of Darjeeling district are formed by the downward movement of materials from the lower Himalayan range through soil erosion and deposition in a broad strip along the foot hill areas. They also support that the surface soil posses a sandy loam and silty loam of few centimeters and the lower strata are formed of water worn sands, rounded stones and gravels. These layers make the soil highly permeable to water besides from the meteriological data (Table-16) it appears that in winter months the rainfall is scarce. Thus frequent irigations are very needed.

The data on soil analysis also reflects that the soil contains low nitrogen and for which application of 'N' fertilizer is required. It has already been worked out and discussed that application of irrigation and N-fertilizer at different optimum levels has shown good performance of *B. campestris* cv. B-54 in the region with special refrence to herbage yield and yield of seed which is the store house of commercially important fixed oil. With they application of both the factors of irrigation and N-fertilizer, the productivity of vegetative parts of the cultivar along with the photosynthetically active green leaves could be possible. Proper irrigation generally increases the reserve soil moisture content which improves the water status and growth of the cultivar. Higher rate of water flow from soil via plant to atmosphere due to less stomatal resistance and more leaf area helps to sustain better transpiration rate in the cultivar, improved the siliquae bearing part in the crop and hence the increase in yield. The increased productivity of vegetative leaves has been augmented by the application of N-fertilizer. That photosynthesis performed by green leaves has a great role on the productivity of seed has been supported by various workers.

Freyman et al (1973) found that leaves of both *B. campestris* and *B. juncea* were exporting labelled assimilates to the seeds. Similar observation was also made by Biswas et al (1990) in different cultivars of *B. campestris* and *B. juncea.* They reported that leaves and stems were the significant source of 14C-labelled assimilates translocated to developing seeds in mustard plants. That photosynthates produced in leaves were the important source to maintain development of seed was supported by defoliation experiment carried out in *B. napus* by several authors (Tayo and Mergan 1979; Williams et at 1979) $14Co_2$ feeding trials showed that leaves constitute to seed development during ripening phase (Brawand Thies 1977).

It is now well established that oils of *B. campestris* and other mustard crops are nothing but simple lipids i.e., esters of fatty acids and glycerides of fatty acids with glycerol that are liquid at room temperature. Fatty acids are synthesised from acetyl-CoA produced out of carbohydrate metabolism. That isolated chlorplasts have the capacity to incorporate acetate into long chain of fatty acids in presence of light was first described by Smirnov (1960) and this was confirmed by Stumf and James (1963) who worked out that when ATP, CoA, Co_2, oxygen and light were present, palmitic, stearic and oleic acids which are the essential component of mustard oil was produced in those tissues which normally do not store triacyl-glycerol. The chloroplast is the primary source of fatty acids and the endoplasmic reticulum in the cytosol is involved in furthr modifications of acyl moieties (Stumf, 1980).

With these observations it may be stated that physiological role of N-fertilizer in mustard crop like *B. campestris* cv. B-54 have more inclination towards helping “Carbohydrae metabolism” rather than “nitrogen metabolism”.

Thus out of observations in connection with the irrigation of N-fertilizer trial, application of 5 levels of irrigation at 12 DAS, 20 DAS, 30 DAS, 40 DAS and 50 DAS to check water stress and 5 levels of N-fertilizer at 15 DAS; 25 DAS, 35 DAS, 45 DAS and 55 DAS to avoid salf stress may be recommended for growing *B. campestris* cv. B-54 in the ecological condition of Darjeeling district, West Bengal.

SUMMARY

In order to work out the optimum rate of application of irrigation and nitrogen to show maximum productivity of *Brassica campestris* B-54 in the ecological condition of Darjeeling district West Bengal, investigation has been carried out.

Seedlings of the cultivar have been raised in a randomised block desing with three replication in the experimental plot for research in North Bengal University situated in the plains of the district. They have been growing the 30cms spacing row to row and 15 cms plant to plant in 4m x 5m plots in the month of October.

Maximum of six levels of irrigation treatments have been adopted during the growing period of the cultivar.

Nitrogen fertilizer has been used in the form of urea and maximum of seven levels of N-fertilizer treatment have been adopted. The initial dose of 30 kg/ha has always been used and the subsequent doses have been restricted to 20 kg/ha. applied at varying interval of time.

Various growth parameters such as height of the plant, number of primary and secondary branches, number of siliquae/plant, number of seeds / siliqa and seed yield/ha have been taken into consideration.

The cultivar has shown maximum of plant height (67.4cm), no of primary branches (3.5), no of secondary branches (6.2), no of siliquae / plant (74.1), no of seeds / siliqua (6.4) and seed yield / ha (4.7q) under natural rainfed condition i.e. without involving irrigation treatment, though four levels of irrigation has been observed to be optimum to show maximum seed yield (7.3 q/ha), no of siliquae/plant (90.6) and no of seeds per siliqua (9.1).

In connection with the consideration of both the treatments of irrigation and N-fertilizer, 5 levels of irrigations (at 12 DAS, 20 DAS, 30 DAS, 40 DAS and 60 DAS) and 5 levels of N-fertilizer (30 kg at 15 DAS, 20 kg at 25 DAS, 20 kg at 35 DAS, 20kg at 45 and 20 kg at 55 DAS) to be the best regarding performances of seed yield. (6.60 q/ha), number of siliqua / plant (220.0) and number of, seeds / siliqua (18.40) and the combination of which has been recommend for commercial utilization of *B. campestris* B-54 in the plains of Darjeeling district, West Bengal.