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EFFECT OF NITROGEN AND BIOFERTILIZERS ON GROWTH AND YIELD OF RADISH (Raphanus Sativus L.) UNDER MID HILLS CONDITION OF HIMACHAL PRADESH

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ABSTRACT

Feld studies were conducted to study the effect of N-biofertilizer and nitrogen on radish *(Raphanus sativus)* during 1995-96 and 1996-97. The results reveales that growh and yield of radish increased linearly with the increase in the application of nitrogen up to 120 kg/ha. The growth and yield from bio-fertilizer inoculated crop was recorded more than that from uninoculated control. Among the bio-fertilizer treatments, inoculation with *Azotobacter* + *Azospirillum* was the best treatment, recording 14.03% more yield than uninoculated control. The interactions of nitrogen and biofertilizer were significant producing highest yield to the tune of 374.64 q/ha at 120 kg N/ha in the presence of *Azotobacter* + *Azospirillum*. The regression equation indicated 124.81 kg/ha as economic optimum dose of nitrogen with an expected yield of 370.60 q/ha in the presence of *Azotobacter* + *Azospirillum*. In general the utility of the use of N-biofertilizer was reduced with increase in N levels and a starter dose of N was needed to have the beneficial effect of biofertilizer(s)

INTRODUCTION

Radish (*Raphanus Sativus* L.) is one of the most popular widely grown root vegetable. Its root and shoot are used for fresh consumption. Radish being a short duration crop, the root growth should be rapid and uninterrupted which need optimum fertilization with nitrogen. The ever increasing cost of nitrogenous fertilizers has emphasized the need for full exploitation of biological nitrogen fixation. Nitrogen fixing bacteria belonging to the group of *Azotobacter* and *Azospirillum* are known to increase the yield of non leguminous crops by 5 to 20% with a saving upto 40% of the recommended dose of N. (Dart 1986). Hence, the investigation was undertaken to study the effect of biofertilizer and nitrogen on growth and yield of radish under mid-hill conditions of Himachal Pradesh.

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MATERIALS AND METHOD

The experiment was conducted, during 1995-96 and 1996-97, at Horticultural Research Station at Kandaghat, District Solan, Himachal Pradesh. The soil of experimental plot was sandy loam having 0.18% available nitrogen, 7.74 and 22.56 ppm available phosphorus and potassium, respectively. The treatments consisting of five nitrogen levels (0, 40, 80, 120 and 160 kg/ha) and four biofertilizer inoculations (Control, *Azotobacter*, *Azospirillum* and *Azotobacter* + *Azospirillum*) were arranged in complete randomized block design with three replications. The seeds of Japanees White cv of radish were inoculated treatment wise before one day of sowing and kept over night for drying and sown next day in the first week of October during both the years of experimentation. Half dose of nitrogen treatmentwise was applied at the time of sowing and remaining half was top dressed one month later. The plants were maintained at a spacing of 30 cm between row and 10 cm between plants in a plot size of 10 m2. Observations were recorded on growth and yield attributed at the time of harvesting.

RESULTS AND DISCUSSION

Effect of nitrogen

Application of nitrogen at increased levels significantly influenced growth and yield of radish except germination percentage (Table 1). Root length and diameter increased significantly up to 120 kg N/ha and further increase was not significant. Maximum leaves per plant were recorded at 160 kg N/ha. Similar increase in growth attributes in radish was reported by Ghanti *et al.* (1989), which might be due to the accelerated synthesis of protein and enzymes resulting in increased root length, diameter and leaf number/ plant due to application of nitrogen (Rajput and Singh, 1982). Root weight/plant and radish yield/hectare were also increased linearly only up to 120 kg. N/ha recording highest yield to the tune of 356.29 q/ha at 120 kg N/ ha which was 28.38 and 12.56% higher over 40 and 80 kg N/ha, respectively. Like wise the highest harvest index and recorded with 120 kg N/ha. The yield increase with nitrogen fertilizaiton was brought about mainly by increased length, diameter and weight of root / plant as well as leaf area index. Srinivas and Naik, 91990) reported higher root weight/plant and yield with increase due to nitrogen fertilisaiton up to 150 kg N/ha.

Effect of Biofertilizers

Seed inoculation with *Azotobacter* or *Azospirillum* improved the growth and yield of radish but when these biofertilizers were applied together, the growth and yield increased tremendously leading to highest yield (315.94 q/ha) with *Azotobacter* + *Azospirillum* (I_3). The highest yield recorded at I_3 was 14.02% more over control. The yield increase was due to consequent increase of root length, diameter and leaf area index as a result of the action of these micro-organism (Sundravelue and Muthukrishanan, 1993).

It was also clear form the study that biofertilizer treatments alone was not sufficient to increase the yield of radish but also required the necessary inputs by way of supplementing inorganic nitrogen. This observation has been substantiated by the findings of interaction effect of biofertilizer and nitrogen levels (Table, 2). Among the interaction effects, I_3N120

(*Azotobacter* + *Azospirillum* + 120 kg N/ha) recorded the highest yield which was 13.49 and 12.21% more over the yield recorded with their respective control and 160 kg N/ha without biofertilizer application. It indicated that maximum yield could be produced with 120 kg N/ha along with *Azotobacter* + *Azospirillum*. Similar increase in growth and yield due to *Azospirillum* along with nitrogen was reported in cauliflower by kalyani *et al.* (1996). The response to applied nitrogen under the influence of different biofertilizer treatments was maximum at lower dose, i.e. 40 kg N/ha which was observed to be declined gradually up to the highest nitrogen dose tried (Table 3). The highest response of nitrogen was with *Azotobacter* + *Azospirillum* followed by *Azotobacter* and *Azospirillum* alone.

Since the soil were low in nitrogen a positive response to nitrogen could be expected. Quadratic response equation fitted to the yield under the influence of different biofertilizer treatments (Table 4) indicated optimum nitrogen levels of 131.36, 137.82 and 124.81 kg/ha with *Azotobacter*, *Azospirillum* and *Azotobacter* + *Azospirillum* and the yield at these optimum dose was 359.24, 352.23, and 370.78 q/ha. While without biofertilizer the optimum nitrogen levels worked out to be 157.97 with expected yield of 335.57 q/ha, which made it safe to deduce that with the use of biofertilizer 20-30% nitrogen could be saved, besides an improvement in yield up to 10% in radish under mid hill conditions of Himachal Pradesh. The price of the produce was estimated as Rs. 60/quintal and urea as Rs. 7.48/ kg of nitrogen

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Table 1. Effect of nitrogen and biofertilizers on growth and yield in radish

Treatments	Germination (%)		Root length (cm)		Root Diameter (cm)		No of leaves /plant		Root weight /plant (g)		Yield (q/ha)			Harvest Index	
	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2	Polled	Y1	Y2
Nitrogen levels (kg/ha)															
N_0	94.47	91.10	19.14	20.91	3.03	2.82	12.55	14.06	98.51	94.49	194.09	211.16	202.63	0.52	0.55
N_{40}	95.20	90.43	22.67	22.93	3.69	3.44	14.12	14.84	127.22	125.22	262.98	292.05	277.52	0.56	0.57
N_{80}	95.73	89.83	24.46	23.79	.94	3.78	15.79	18.65	173.21	172.36	306.49	326.57	316.53	0.55	0.59
N_{120}	85.27	91.13	26.11	24.63	4.18	4.82	15.55	19.31	212.50	191.36	346.67	365.91	356.29	0.58	0.61
N_{160}	95.39	91.30	26.06	24.57	3.81	4.95	17.91	20.66	212.21	205.46	344.14	353.73	348.94	0.57	0.61
CD P=0.05	NS	NS	1.10	1.21	0.29	0.3	0.73	0.99	5.58	6.78	11.01	8.95	5.60	0.03	0.02
Inoculation treatments															
I_0	92.07	86.50	22.09	21.54	3.58	3.38	14.02	16.38	146.24	138.43	263.14	291.00	277.07	0.56	0.57
I_1	96.69	92.06	24.29	24.02	3.83	4.06	15.76	18.97	170.39	164.00	297.50	314.16	305.83	0.55	0.58
I_2	96.67	92.21	23.27	23.60	3.45	4.01	15.60	17.54	163.87	156.76	295.68	301.87	301.78	0.54	0.59
I_3	95.41	92.27	25.09	24.03	4.04	4.40	16.94	18.72	178.41	171.93	305.18	326.70	315.94	0.57	0.58
CD P=0.05	2.08	2.24	0.99	1.08	0.26	0.33	0.66	0.89	5.25	6.07	9.85	7.99	5.10	NS	NS

Y1 = 1995-96, Y2 = 1996-97; I0 – Control, I1 = Azotobacter, I2 = Azospirillum and I3 = Azotobacter + Azospirillum

Table 2. Interaction effect of nitrogen and biofertilizers on radish yield

	1995 – 96					1996 – 67					Pooled				
	N_o	N_{40}	N_{80}	N_{120}	N_{160}	N_o	N_{40}	N_{80}	N_{120}	N_{160}	N_0	N_{40}	N_{80}	N_{120}	N_{160}
I_0	175.41	228.17	265.42	320.16	326.54	192.21	175.91	305.66	340.04	341.18	183.81	252.04	285.54	330.10	333.86
I_{az}	193.48	274.19	314.77	356.18	348.89	215.36	296.54	330.54	370.14	358.25	204.42	285.36	322.65	363.16	353.57
I_{as}	204.08	267.46	310.39	350.21	346.29	219.20	285.18	320.52	364.32	350.14	209.14	276.32	315.45	357.26	348.22
I_{az+as}	203.39	282.11	325.40	360.14	354.85	217.89	310.56	349.56	389.15	366.35	210.64	296.34	337.48	374.64	360.60
CD P=0.05			22.2					17.88					11.40		

Table 3. Response of added dose of fertilizer as influenced by biofertilizers

Nitrogen dose	Response of additional fertilizer levels (kg/ha)			
	Control	*Azotobacter*	*Azospirillum*	*Azotobacter* + *Azospirillum*
0	00	00	00	00
40	170.57	202.35	187.95	214.25
80	127.16	147.79	132.89	158.55
120	121.90	132.28	123.43	136.67
160	93.78	93.22	86.92	93.73

Table 4. Fitted response function in radish as affected by nitrogen under the influence of biofertilizers.

Treatmetns	Regression equation	r^2	Optimum Dose (kg/ha)	Expected yield (q/ha)
Without biofertilizer	$Y = 184.60 + 1.78704\ N - 0.0052625N^2$	0.98	157.97	335.56
With Azotobacter	$Y = 205.21 + 2.02105\ N - 0.007993N^2$	0.96	131.36	359.24
With Azospirillum	$Y = 208.06 + 1.9675\ N - 0.0066857N^2$	0.97	137.82	352.23
With Azotobacter + Azospirillum	$Y = 210.59 + 2.4423\ N - 0.0092844N^2$	0.97	124.81	370.78