Indian Journal of Hill Farmg 15(2) : 22-26 (2002)

INFLUENCE OF NITROGEN AND BIOFERTILISERS ON GROWTH, YIELD AND QUALITY IN RADISH

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ABSTRACT

A field experiment was conducted on sandy loam soil to study the effect of nitrogen and biofertilisers on growth, yield and quality of radish (*Raphanns sativus* L). Application of nitrogen at increased levels improved growth and yield upto 120 kg/ha, thereafter non significant effect was noticed. Among the quality attributes, total soluble solids (TSS) was found to increase gradually, while ascorbic acid contents decreased due to increased in nitrogen level. Of the biofertiliser treatments, inoculation with Azotobacter and Azospirillum improved growth, yield and TSS but ascorbic acid decreased as compared to their single inoculation. The efficiency of biofertiliser was higher at low nitrogen levels and found to decrease with the increasing level of nitrogen, while the synthesis of nitrogen in plant improved only upto 80 kg N/ha with biofertiliser.

INTRODUCTION

The yield and quality of crop can be improved by application of required amount of nutrients through chemical fertilizer which is an essential pre-requisite and upto certain extent, a general practice. Among the various nutrients, nitrogen is one of the most important nutrient required in substantial qualities. In recent years, the price of inorganic fertilizer has gone up considerably, which in turn has increased the cost of production. As such it has become imperative to search their complimentary/alternative resources. Fertiliser of biological origin, i.e. biofertilisers can meet this challenge. The use of biofertiliser, i.e. *Azotobacter chroococcum* and *Azospirillum brasilence* to supplement the nitrogen in radish gave encouraging results (Sundravelue and Muthukrishanan, 1993). Besides fixing the nitrogen, these biofertilisers provides growth promoting substances and antifungal antibiotics, which in tern facilitates uniform germination, improve seeding vigour resulting in healthy plant stands leading to higher yield (Shende, et al., 1977). Since the information on these aspects are very meager, a study was therefore, carried out to find out the influence of graded dose of nitrogen and biofertiliser on growth, yield and quality attributes in radish under mid hill conditions of Himachal Pradesh.

MATERIALS AND METHODS

Field experiments were carried out at the experimental farm of Horticultural Research Station Kandaghat, Solan (HP), during summer seasons of 1995-96 and 1996-97 on well drained sandy loam soil having 0.18% available nitrogen, 7.74 and 22.56 ppm available phosphorous and potassium, respectively. The experiment comprising of five nitrogen levels (N_0, N_{40}, N_{80}, N_{120} and N_{160} Kg N/ha) and four biofertiliser treatments (uninoculated, Azotobacter, Azospirillum and Azotobacter + Azospirillum) were tested in two factors randomized block design with three replications. The seeds of Japanees white radish variety were inoculated treatment wise and kept overnight for drying and sown next day in the first week of October during both the years of experimentation. The experimental field was also given soil treatment with respective biofertiliser @2kg/ha in line at the time of sowing. Half dose of nitrogen as per treatments through urea along with 50kg each of P_2O_5 and K_2O as single supper phosphate and muriate of potash, respectively, were applied

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at the time of transplanting and remaining half of the nitrogen was top dressed after 30 days of sowing. The plants were maintaining at a spacing of 30cm x 10cm in a plot size of $10m^2$ and all package of practices were followed for healthy crop stand. The data on growth and yield were recorded at harvesting as per standard procedure. The chlorophyll contents in leaf tissue and Ascorbic acid contents were estimated by using method of Hiscox and Isrealstom(1979) and Person (1970), respectively and TSS were determined with Erma Hand Refrectometer.

RESULTS AND DISCUSSION

Influence of nitrogen

Application of nitrogen from 0 to 120 kg/ha with an increment of 40 kg/ha significantly increased the dry matter accumulation (DM) and leaf area index(LAI). Beyond 120 kg N/ha, the DM and LAI increased during 1995-96 and decreased in 1996-97 but the difference was not significant. This may be due to optimum availability of nitrogen, through improved chlorophyll synthesis which resulted into the improvement in number of leaf of longer size (Table 1) leading to increase in LAI and finally enhancement of dry matter production. The yield of radish significantly increased with the increasing levels of nitrogen application upto 120 kg/ha, which was 75.83 and 2.10% higher over control and 160 kg/ha, respectively. Higher yield due to 120 kg N/ha may be due to more DM accumulation in root and shoot in radish. These results are in conformity with those of Joshi and Patil(1992).

Root quality in terms of TSS and Ascorbic acid contents were influenced significantly with the application of nitrogen at various levels. Highest TSS were recorded in radish roots received higher nitrogen doses i.e.160 kg N/ha, which was statistically at par with TSS in the roots of plants received 80 and 120 kg N/ha (Table2). Contrary to this, the ascorbic acid content decreased with the corresponding increase in nitrogen up to 160 kg N/ha probably due to interaction of nitrogen in hormonal metabolism of plant with auxin (Joshi and Patil, 1988; Singh et al. 1992).

Effect of biofertilisers

Inoculation of seed and soil with Azotobacter and Azospirillum, alone or in combination, significantly improved growth, yield and quality attributes of radish. Among the biofertiliser treatments, combined inoculation proved to be the best recording highest DM of 25.80 and 28.38 g/plant during 1995-96, respectively. Single inoculation also increased the DM in plant as compared to control. This is attributed to the growth homones like IAA and IBA produced by these bacteria besides nitrogen fixation (Mohandas, 1989) which induced change in root and shoot morphology. The LAI was also maximum at this treatment which was statistically superior to control during 1995-96 while during 1996-97 it was superior to control and Azospirillum alone. The chlorophyll contents were higher in inoculation treatments as compared to control. While the single or combined inoculation of Azotobacter and Azospirillum were on par in the synthesis of chlorophyll. The increase in chlorophyll 'a' and 'b' contents due to seed inoculation with biofertiliser is attributed to the continuous availability of nitrogen which is an integral part of chlorophyll. Maximum radish yield of 315.94 q/ha recorded with combined inoculation treatment was 14.02% higher over uninoculated control (Table 1). Single inoculation with Azotobacter and Azospirillum also increased 10.38 to 8.92% higher yield than control. The beneficial effect of biofertilisers might have increased the number of leaves of longer size resulting into increase in LAI, DM and ultimately yield of radish (Sundravelue and Muthukrishana, 1993).

Application of biofertiliser increased the TSS as compared to control (Table 2). Combined inoculation with Azotobacter and Azospirillum recorded highest TSS followed by single inoculation with Azotobacter or Azospirillum during 1995-96. However, during 1996-97 the same pattern was observed but the difference was not significant. Contrary to TSS, biofertiliser treatment reduced the ascorbic acid content in radish root. Highest ascorbic acid contents were recorded in roots grown without biofertiliser while lowest was with combined inoculation with Azotobacter and Azospirillum during both the years of experimentation (Table 3).

It is also clear from the study that biofertiliser treatment is not sufficient to promote the growth of radish but also requires the necessary inputs by way of supplementing inorganic nitrogen. The observation has been substantiated by the observation of the results due to interaction effect of biofertiliser and nitrogen (Table 2). Among the interaction effect, the combined inoculation with Azotobacter and Azospirillum in the presence of 120 Kg N/ha recorded highest values for the DM production and yield of radish, which were statistically superior when compared to nitrogen or biofertilizer treatment alone, indicating the maximum yield can be produced with 120 Kg N/ha application when applied along with Azotobacter + Azospirillum. Similar increase in growth and yield was reported in cauliflower by Kalyani et al (1996) and in okra by Subbaih (1991). The efficiency of biofertiliser (s) in improving the yield was maximum with lower dose of nitrogen (40 kg N/ha) which decreased with the increase in nitrogen levels upto 160 kg N/ha, while in case of DM production the maximum efficiency was estimated with no nitrogen treatment which reduced with the increasing levels of nitrogen. Wani et al (1986) reported better efficiency of Azospirillum at lower dose of nitrogen than higher doses. This suggest that the response of biofertiliser inoculation would be good when level of nitrogen were sub optimal (Kapulink, et. Al 1987).

The amount of nitrogen fixed in plant by introduced biofertiliser over and above native population was estimated (Table 5), which revealed that nitrogen fixation in plant increased with the application up to 80 kg N/ha at all biofertiliser (s), thereafter it reduced. Among the biofertiliser, Azotobacter + Azospirillum found to synthesize more nitrogen in plant at all nitrogen levels as compared to their single inoculation. However, maximum nitrogen of 58.81 kg/ha was estimated to be fixed in plant obtained from the seed and soil inoculation with Azotobacter + Azospirillum in the presence of 80 kg N/ha. This shows that at 50% of the applied dose of nitrogen, biofertiliser inoculation was beneficial in synthesizing the nitrogen in plant, which may be due to increased DM production or relative nitrogen concentration due to the effect of plant growth substances and nitrogen fixation or nitrogen assimilation by Azotobacter and Azospirillum as suggested by Boddey et al (1986).

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Table 1. Influence of nitrogen and biofertiliser on growth and yield of radish

Treatments	Dry Matter Production (g/plant)						LAI		Chlorophyll contents				Yield (q/ha)	
	Shoot		Root		Total				'a'		'b'			
	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2
Nitrogen Levels (kg/ha)														
N0	5.05	4.48	6.37	6.03	11.52	11.42	1.61	1.52	0.372	0.386	0.238	0.192	194.09	211.16
N40	8.43	8.86	11.14	11.53	19.46	19.58	3.02	2.56	0.502	0.478	0.304	0.313	262.98	292.05
N80	11.91	12.57	16.97	14.86	27.05	28.28	3.39	3.27	0.564	0.559	0.411	0.357	306.49	326.57
N120	13.96	12.66	21.47	17.97	30.04	35.43	3.75	3.68	0.609	0.592	0.406	0.419	346.67	365.91
N160	14.10	12.89	20.40	18.05	31.44	34.50	3.97	3.47	0.609	0.604	0.399	0.382	344.14	353.73
CD (P=0.05)	0.92	1.12	2.93	2.56	1.96	2.03	0.33	0.12	0.016	0.074	0.015	0.049	11.01	8.95
Biofertiliser inoculation														
Control	9.08	8.66	13.54	12.13	20.79	22.57	2.79	2.49	0.454	0.464	0.336	0.291	263.14	291.00
Azotobacter	11.01	10.55	15.48	13.79	24.73	26.49	3.24	3.01	0.566	0.544	0.363	0.333	297.50	314.16
Azospirillum	10.84	10.88	15.50	13.40	24.28	26.34	3.22	2.92	0.544	0.525	0.347	0.331	295.68	301.87
Azotobacter + Azospirillum	11.83	11.88	16.55	15.43	25.80	28.38	3.33	3.17	0.559	0.552	0.361	0.375	305.18	326.7
CD (P=0.05)	0.82	1.01	2.63	2.29	1.76	1.821	0.30	0.11	0.014	0.067	0.014	0.044	9.85	7.99

Y1 and Y2 are 1995-96 and 1996-97.

Table 2. Interaction effect of nitrogen and biofertiliser on dry matter production and yield of radish

Treatments	1995-96				1996-97			
	B0	B1	B2	B3	B0	B1	B2	B3
Dry matter production (g/plant)								
N0	9.11	12.25	11.75	12.97	7.95	12.06	12.33	13.35
N40	15.49	20.88	20.72	20.75	15.50	20.79	20.09	21.93
N80	23.64	27.47	27.02	31.05	24.67	29.41	29.31	32.11
N120	25.85	31.61	30.03	32.66	31.87	36.20	35.51	38.15
N160	29.87	31.42	31.89	32.57	23.14	33.90	34.48	36.38
CD (P=0.05)		3.93			3.86			
Yield (q/ha)								
N0	175.41	193.48	212.08	211.29	192.21	245.36	253.20	254.89
N40	265.17	384.19	380.34	398.11	305.91	414.67	406.18	419.79
N80	437.42	481.77	463.39	511.40	472.66	511.25	494.25	524.56
N120	499.16	536.18	514.21	553.14	544.06	585.14	551.81	590.10
N160	519.29	539.89	533.21	531.92	543.55	583.13	558.30	578.98
CD (P=0.05)		22.20				17.88		

B0=Control, B1=Azotobacter, B=Azospirillum and B3=Azotobacter + Azospirillum

Table 3. Effect of Nitrogen and biofertiliser on quality attributes in radish

Treatments	Total Soluble Solids in roots (TSS (%)		Ascorbic acids in roots (mg/100 g)	
	Y1	Y2	Y1	Y2
Nitrogen levels (Kg/ha)				
N0	3.23	3.36	17.17	16.74
N40	3.54	3.57	16.48	15.88
N80	3.97	3.98	16.09	15.59
N120	4.13	4.04	16.03	15.29
N160	4.21	4.20	15.65	15.16
CD (P=0.05)	0.32	0.51	0.46	0.50
Biofertiliser Inoculation				
Control	3.50	3.69	17.04	16.38
Azotobacter	3.86	3.90	16.06	15.49
Azospirillum	3.85	3.70	16.17	15.71
Azoto + Azospi	4.04	4.03	15.85	15.36
CD (P=0.05)	0.29	NS	0.41	0.45

Y1 and Y2 are 1995-96 and 1996-97

Table 4. Effect of nitrogen on biofertiliser efficiency in improving various parameters in radish

Treatments	N0	N40	N80	N120	N160
		Radish Yield (q/ha)			
Azotobacter	19.37	39.86	9.11	7.45	5.66
Azospirillum	26.57	37.70	5.23	4.66	2.73
Azotobacter + Azospirillum	26.83	43.19	13.83	9.59	4.52
		Dry Matter production (g/plant)			
Azotobacter	42.44	34.45	17.72	17.50	3.78
Azospirillum	41.15	31.68	16.60	13.55	5.33
Azotobacter + Azospirillum	54.28	34.45	28.64	20.96	9.43

Table 5. Amount of nitrogen fixed in plant (kg/ha) by introduced biofertiliser over and above the native population (By difference method)

Treatments	N0	N40	N80	N120	N160
Azotobacter	17.04	31.96	38.86	31.84	8.59
Azospirillum	16.23	29.63	35.75	24.60	14.15
Azotobacter + Azospirillum	21.36	46.52	58.81	52.04	21.84