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Response of amaranth *(Amaranthus hypochondriacus)* to levels and time of nitrogen application

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ABSTRACT

A field experiment was conducted during the rainy season *(kharif)* of 1996 and 1997 to find out the optimum dose of nitrogen and an appropriate time of its application to amaranth *(Amaranthus hypochondriacus* L.) at Ranichauri. The grain yield was significantly increased up to 80 kg N/ha. The optimum and maximum yield doses estimated through quadratic response were found to be 91.89 and 105.60 kg/N/ha respectively. The benefit : cost ratio was negative beyond 101 kg N/ha. Plant height and grain weight/plant were also increased up to 80 kg N/ha. The harvest index was, however, highest with 40.0 kg N/ha. Plant stand at harvest and test weight remained unaffected. Nitrogen application in 2 splits, i.e. half at sowing and half 50 days after sowing also significantly increased the grain yield and plant height over single and 3 splits.

Key words : Amaranth, Nitrogen, Split application

Yield and quality both are the major constituents of food security in 21st Century. Amaranth being a C_4 plant has more efficiency of nitrogen utilization and photosynthesis (Megomedov *et al.*, 1997) along with yield potential of more than 50 q/ha. This is also a rich source of minerals, such as iron, phosphorus and calcium. Besides having a significant value as fast food, it is also used as leafy vegetable. The stalks are generally used as fuel for household cooking. Above all, the crop has a wide adaptability and also shows good response to production inputs like nitrogen (Bhaskar *et al.*, 1996; Joshi and Rana, 1991) and its time of application.

MATERIALS AND METHODS

A field experiment was conducted at Hill Campus of the University at Ranichauri during the rainy season of 1996 and 1997. The treatments consisting of 4 levels of nitrogen (0, 40, 80 and 120 kg/ha) and 3 times of application (whole N as basal; half N as basal + half at knee-high stage (50 days after sowing); and half N as basal +

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one-fourth at knee-high + one-fourth at flower bud-initiation stages) were tested in factorial randomized block design with 3 replications. Phosphorus at 40 kg and potassium at 30 kg/ha were also applied as basal dressing at the time of sowing. The amaranth var. 'Annapurna' was sown on 24 June and 30 May and harvested on 10 November and 28 October in 1996 and 1997 respectively. The soil of experimental field was silty clay loam, medium in depth and moderately acidic (pH 5.5 to 6.6). It was low in available nitrogen (220–225 kg N/ha), medium in available phosphorus (8.5–10.0 kg P/ha) and rich in available potash (345–350 kg K_2O/ha). The region belongs to subhumid climate with an annual rainfall of 1,241.1 mm and 40–45 relative humidity. The rainfall received during the crop season was 756.20 and 770.70 mm distributed in 59 and 68 days in 1996 and 1997 respectively.

RESULTS AND DISCUSSION

Nitrogen

Levels of nitrogen did not affect the plant stand at harvest. Plant height was found to be increased with increase in N from zero to 120 kg N/ha (Table 1) in 1996. While increase in plant height was only up to 80 kg N/ha in 1997. An early sowing might have increased the plant height of amaranth in general and neutralized the response of higher levels of N in 1997. Similarly, grain weight/plant increased with the increase in the N level. However, there was no significant difference between grain weight under 80 kg N and 120 kg N /ha. Test weight, i.e. 1,000-grain weight, remained unaffected due to different levels of N, while harvest index was highest under 40 kg N/ha. Both lower and higher levels of N affected the harvest index adversely. Luxuriant growth and transformation of photosynthates to the grains might have attributed towards lower harvest index at higher level of N.

The grain yield responded significantly to the levels of N and in 1996 the yield increased up to 120 kg N/ha, though there was no significant difference between the yield of 80 kg and 120 kg N/ha (Table 2). Similarly, in 1997, 80 kg and 120 kg N/ha were found at par with each other. On mean basis too, the increase in grain yield was significant up to 80 kg N/ha. The increase in grain weight/plant in relation to graded doses of nitrogen might have resulted in increase of grain yield up to 80 kg N/ha.

A significant correlation was observed for quadratic response ($Y = 4.425 + 8.921 \times - 1.225 \times^2$) and optimum and maximum fertilizer doses were estimated to be 91.89 and 105.60 kg N/ha respectively. Joshi *et al.* (1983), however, recommended a fertilizer level of 50, 50 and 20 kg N, P_2O_5 and K_2O/ha. Availability of sufficient moisture through rains during entire growing season might have been one of the reasons of increased response of N to higher levels. The benefit : cost ratio was, however, decreased with increase in N levels and was positive (1.19) up to 101 kg N/ha only).

Time of application

Time of nitrogen application did not affect plant stand at harvest (Table 1). The plant height, however was increased under split application, though the results were

Table 1. Growth and yield characters of amaranth

Treatment	Pant stand/m at harvest		Plant height (cm)		Grain weight (g/plant)		1,000-grain weight (g)		Harvest index (%)	
	1996	1997	1996	1997	1996	1997	1996	1997	1996	1997
N (kg/ha)										
0 (control)	6.2	5.0	89.0	77.7	19.6	7.4	0.84	0.93	29.3	34.4
40	6.1	5.3	115.6	118.6	21.7	8.9	0.83	1.02	33.0	37.6
80	6.4	5.3	116.7	145.2	25.2	14.7	0.81	0.91	33.1	28.0
120	6.4	5.3	133.8	144.2	28.1	16.3	0.80	0.97	28.0	28.0
CD_1 (P = 0.05)	NS	NS	7.3	15.6	4.3	3.9	NS	NS	6.2	7.9
CD_2 (P = 0.05)	NS	NS	5.1	11.1	3.1	2.8	NS	NS	4.4	5.9
Time of application										
Whole N as basal	6.3	5.3	122.9	132.4	24.0	12.8	0.80	1.04	30.2	30.2
In 2 splits	6.4	5.4	127.5	132.8	46.3	13.3	0.82	0.89	31.4	33.2
In 3 splits	6.2	5.3	115.8	142.7	24.8	13.7	0.82	0.97	32.7	30.2
CD (P=0.05)	NS	NS	5.1	NS	NS	NS	NS	NS	NS	NS

CD_1, To compare N levels with control; CD_2 to compare different N lavels

Table 2. Grain yield (q/ha) and economic returns of amarnath

Treatment	Grain yield (q/ha)			Economic returns	
	1996	1997	Mean	Marginal response (kg)/ level/split	Benefit: cost ratio
N kg/ha					
0 (control)	14.28	11.11	12.17		
40	19.45	15.00	17.22	12.62	14.98
80	21.02	19.59	20.31	7.72	9.16
120	22.34	18.58	20.46	0.37	0.44
CD_1 (P=0.05)	3.01	4.20	1.52		
CD_2 (P=0.05)	2.13	2.97	1.08		
Time of application					
Whole N as basal	19.97	16.46	18.22		
In 2 splits	22.37	18.31	20.34	212.00	53.00
In 3 splits	20.37	18.39	19.43	(-)91.00	(-)22.75
CD (P = 0.05)	2.13	NS	1.08		

CD_1, To compare N levels with control; CD_2 to compare different N lavels

Cost of N fertilizer (urea): Rs 8.43/kg N; sale price of amarnanth, Rs 10/ kg; cost of labour for split application, Rs 40/ha.

significant in 1996 only where application in 2 splits recorded the highest plant height (127.5 m). Grain weight/plant, 1,000-grain weight and harvest index also could not be affected. The split application of N also increased the grain yield over single application, significantly only in 1996 and application of N in 2 splits, i.e. half as basal at sowing time and rest half at knee-high stage, recorded highest grain yield of 22.37 q/ha. The difference between the yield under 2 and 3 splits was, however, non-significant. On mean basis too, the grain yields under 2 and 3 splits were found at par with each other. The non-utilization of N applied at flower initiation in third split might have not been utilized by the crop for grain development. Thus, effective utilization of only three-fourths of total N applied up to knee-high stage in 3 splits reduced the grain yield compared with 2 splits. The marginal response and benefit : cost ratio were also estimated to be negative with N application in 3 splits.

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