

EFFECT OF IRRIGATION AND NITROGEN ON TOMATO YIELD IN THE GREY TERRACE SOIL OF BANGLADESH

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ABSTRACT

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An experiment was conducted at Central Research Station, BARI, Joydebpur during rabi season of 2003-04 and 2004-05 to study the effect of irrigation and nitrogen on tomato (Var.BARI Tomato-9). Sixteen treatment combinations comprising 4 irrigation (IW: CPE ratios of 0.6, 0.8, 1.0 and a rainfed condition) and 4 levels of nitrogen (0, 80, 160 and 240 kg ha⁻¹) were tested in a split plot design with three replications. Irrigation and nitrogen alone and in combination influenced the yield and yield contributing characters of tomato. From the response curve of average yield data of 2003-04 and 2004-05, optimum N dose was recorded to be 163.3 kg ha⁻¹ and economic dose 182.3 kg/ha. At the same time optimum average fruit yield was recorded 50.43 t ha⁻¹. Total water use recorded was 15.48, 26.71, 29.10 and 31.20 cm in 2003-04 and 16.80, 27.79, 31.97 and 32.81cm in 2004-05 for rainfed condition and IW: CPE ratios of 0.6, 0.8 and 1.0, respectively. The total number of irrigation at 0.6, 0.8, and 1.0 ratio came out to be 3, 4 and 5, respectively during the rabi season of 2003-04 and 2004-05.

Key words: Irrigation, nitrogen, evapotranspiration, yield

INTRODUCTION

Tomato (*Lycopersicon esculentum* L.) is the most consumable vegetable crop and its production 0.122 million metric tons against total vegetable production of 6.67 million metric tons annually (BBS, 2005). It is used as canned vegetable having multiple uses (Chowdhury, 1979). Tomato responds to liberal application of water and N (Gupta and Rao, 1978; Csizinsky, 1980; Vasantha Kumar, 1984). The recommended N application rate for fresh market tomato production is 212 to 269 kg N ha⁻¹ (Hochmuth *et al.*, 1988). Nasreen and Islam (1990) reported that adequate N and P increased fruit yield more effectively than any other nutrients. However, increasing demands for water and high costs of N fertilizers necessitate their judicious use in tomato production. Mridha *et al* (2003) reported seven days interval irrigation with standard doses of fertilizer application. But irrigation may not be required if soil moisture is available. So it is dependent on evapotranspiration. Rahman (2005) is more effective if it is applied on the basis of IW: CPE ratios. This needs for determination of optimum scheduling of irrigation and N requirement. Present study was therefore made to find out the suitable irrigation schedule based on IW: CPE ratios under varying levels of N for optimum growth and yield of tomato at Grey Terrace soil of Joydebpur.

MATERIALS AND METHODS

A field experiment was conducted during rabi season of 2003-2004 and 2004-2005 at central research station, BARI, Joydebpur. The treatment comprised 4 levels of irrigation based on IW: CPE ratio which were: I₀ (a rainfed condition-control), I₁ (IW/CPE: 0.6), I₂ (IW/CPE: 0.8) and I₃ (IW/CPE: 1.0) and 4 levels of N were : 0,80, 160 and 240 kg/ha. The experiment was laid out in a split plot design with 3 replications. Irrigation was assigned in the main plot and nitrogen in the subplot. The unit plot size was 3m x 2.4m and tomato spacing 60cm x 40 cm. A fertilizer dose of 45-80-20-01 PKSB kg ha⁻¹ and 5 t ha⁻¹ cowdung were applied at the final land preparation. One-third nitrogen was applied during final land preparation and remaining nitrogen was applied in two equal splits at 20 and 40 days after transplanting. The 30 days old healthy seedlings of BARI Tomato-9 were planted in the experiment on 01st December of 2003 and 2004. Tomato fruit was harvested in the first week of March of the year 2004 and 2005.

The irrigation (4.0cm) was applied when cumulative pan evaporation reached 67, 50 and 40 mm of 0.6, 0.8 and 1.0 IW: CPE ratios. The mean minimum temperature was recorded 15.32 °C in 2003-04 and 14.24 °C in 2004-05. Mean maximum temperature were 29.22°C and 28.44°C for the respective year. The total rainfall received during crop period was 8.8 mm and 9.9 mm for the year 2003-04 and 2004-05.

Cultural practices were done as and when necessary. Ten plants from each plot were selected for data collection of plant height, number of branch/plant, number of fruits/plant and wt. of fruit/plant. Fruit yield was recorded on the whole plot basis. Data recorded on yield and yield-contributing characters were subjected to statistical analysis through analysis of variance and mean separation done following Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Effect of irrigation

Effect of irrigation on yield and yield contributing characters of tomato are presented in Table-1. In the year 2003-04 the highest fruit yield 51.54 t ha⁻¹ was recorded with irrigation at IW: CPE ratio of 1.0 which was significantly

higher than that of IW: CPE ratio of 0.6 and rainfed condition. But the treatment IW: CPE-1.0 failed to produce significant yield difference with IW: CPE-0.8. The lowest yield (28.09 t ha⁻¹) was recorded from rainfed plot.

In the year 2004-05 the highest fruit yield 57.12 t ha⁻¹ was recorded with irrigation at IW: CPE ratio of 1.0 which was significantly higher than that of IW: CPE ratio of 0.8, 0.6 and rainfed condition. The lowest yield (30.31 t ha⁻¹) was recorded from rainfed plot. The number of irrigation required for IW: CPE ratio of 0.6, 0.8 and 1.0 were 3, 4 and 5, respectively. The other parameters followed the same pattern except plant height.

Table 1. Effect of irrigation on yield and yield contributing characters of toamto

Treatment	Plant height (cm)		No. of fruits plant ⁻¹		Fruit wt. plant ⁻¹ (g)		Yield (t ha ⁻¹)	
	03-04	04-05	03-04	04-05	03-04	04-05	03-04	04-05
I ₀ (Control)	47.1c	46.92b	26d	26.3d	749.0d	760.4d	28.09d	30.31d
I ₁ IW/CPE:0.6	50.4b	51.22b	44c	43.5c	1131.0c	1176.0c	39.38c	42.76c
I ₂ IW/CPE:0.8	54.5a	55.62a	48b	50.0b	1413.0b	1446.0b	47.48a b	50.37b
I ₃ IW/CPE:1.0	55.3a	57.48a	53a	56.0a	1581.0a	1653.0a	51.54a	57.12a
CV (%)	12.4	14.5	13.7	12.8	15.4	12.8	12.8	14.6

Effect of Nitrogen

The effect of Nitrogen on the yield and yield components of tomato was presented in Table 2. In the year 2003-04, different nitrogen levels showed significant variations in all the characters except number of fruit plant⁻¹. The highest fruit yield 50.41 t ha⁻¹ was recorded with 160 Kg N ha⁻¹, which was significantly higher than other treatments. The lowest fruit yield (26.85 t ha⁻¹) was obtained from N₀ which is 54% lower than 50.41 t ha⁻¹ by N₂. Hegde and Srinivas (1989) found 35% more tomato fruit yield from 160 kg N ha⁻¹ than control.

In the year 2004-05, different nitrogen levels showed significant variations in all the characters except plant height. The highest fruit yield 51.95 t ha⁻¹ was recorded with 160 Kg N ha⁻¹, which was significantly higher than other treatments. The lowest fruit yield (30.99 t ha⁻¹) was obtained from N₀ which is about 59% lower than 51.95 t ha⁻¹ by N₂.

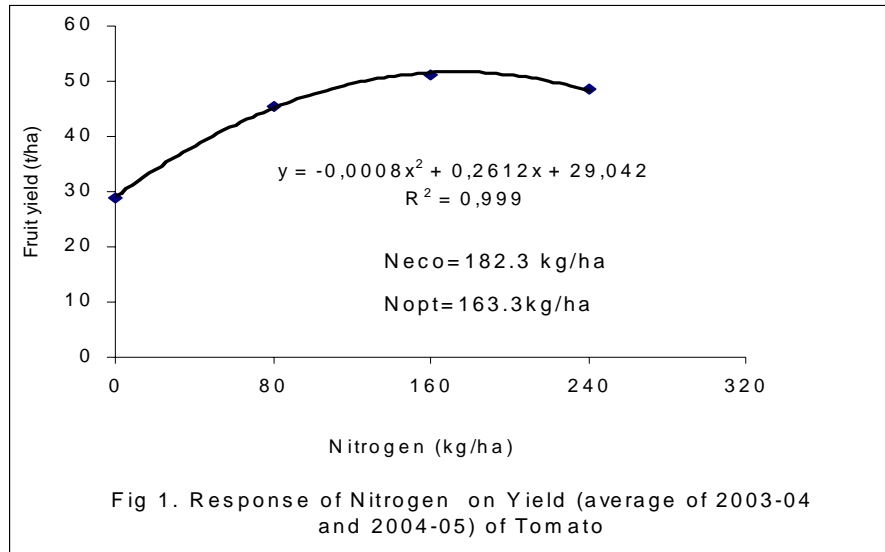
From the response curve, optimum N dose 173.6 kg ha⁻¹, economic dose 166.7 kg N ha⁻¹ and optimum fruit yield was recorded 50.17 t ha⁻¹.

Table 2. Effect of nitrogen on yield and yield contributing characters of tomato

Nitrogen (kg/ha)	Plant height (cm)		No. of fruits plant ⁻¹		Fruit wt. plant ⁻¹ (g)		Yield (t ha ⁻¹)	
	03-04	04-05	03-04	04-05	03-04	04-05	03-04	04-05
0	46.4c	48.68b	36c	33.75d	1022.5d	1047.0d	26.85d	30.99d
80	52.0b	52.40ab	43b	38.75c	1198.16c	1222.0c	43.76c	47.20c
160	55.5a	54.66a	48a	45.52b	1354.0a	1403.0a	50.41a	51.95a
240	53.3ab	55.50a	44b	48.47a	1299.5b	1364.0b	46.47b	50.43b
CV (%)	8.1	8.7	11.9	11.3	11.2	9.6	10.8	7.6

Response analysis

From the response curve of average data of two seasons, optimum N doses were found to be 163.3 kg ha⁻¹. At the same time economic dose recorded 182.3 kg ha⁻¹. The optimum yield was obtained 50.43 t ha⁻¹.



Interaction effect of irrigation and nitrogen

The interaction effect of irrigation and nitrogen on the yield and yield contributing characters of tomato was significant during 2003-04 and 2004-05 (Table 3). In the year 2003-04, the highest fruit yield (59.87 t ha⁻¹) was found in I₃N₂ followed by I₂N₂ (58.34 t ha⁻¹) and I₃N₁ (55.32 t ha⁻¹). But the treatments I₃N₃ and I₃N₂ were statistically insignificant. At the same time treatments I₃N₁ and I₂N₂ failed to produce significant difference. The lowest fruit yield (17.56 t ha⁻¹) found in I₀N₀.

In the year 2004-05, the highest fruit yield (64.65 t ha⁻¹) was found in I₃N₂ followed by I₃N₃ (63.64 t ha⁻¹), I₃N₁ (60.69 t ha⁻¹) and I₂N₂ (58.04 t ha⁻¹). But the treatments I₃N₃ and I₃N₂ were statistically insignificant. At the same time treatments I₃N₁ and I₂N₂ failed to produce significant difference. The lowest fruit yield (19.34 t/ha) found in I₀N₀.

Table 3. Interaction effect of irrigation and nitrogen on yield and yield contributing characters of tomato during 2003-04 and 2004-05

Treatment	Plant height (cm)		No. of fruits plant ⁻¹		Fruit wt. plant ⁻¹ (g)		Yield (t ha ⁻¹)	
	03-04	04-05	03-04	04-05	03-04	04-05	03-04	04-05
I ₀ N ₀	40.4f	42.13e	18j	19m	635m	644.7k	17.56k	19.34m
I ₀ N ₁	46.8de	46.93cde	28i	23l	724l	726.3j	28.46i	31.78k
I ₀ N ₂	52.5abcd	48.33bcde	33h	35j	826k	844.7i	33.82g	35.34ij
I ₀ N ₃	48.6cde	50.27bcde	26i	28k	810k	826.0i	32.54gh	34.78j
I ₁ N ₀	44.3ef	46.87de	35h	37i	902j	944.0h	24.34j	28.32l
I ₁ N ₁	50.7bcde	49.47bcde	43g	44h	1110i	1145.0g	38.23f	44.35g
I ₁ N ₂	54.5abc	55.57abc	50cd	48e	1298g	1325.0de	49.62d	49.75f
I ₁ N ₃	52.0abcd	53.00abcd	46ef	45g	1214h	1288.0ef	45.32e	48.64f
I ₂ N ₀	48.5cde	51.60abcd	44fg	45g	1205h	1226.0f	30.25hi	36.78i
I ₂ N ₁	55.3abc	56.27ab	48de	48e	1372e	1400.0c	53.04bc	52.00e
I ₂ N ₂	56.3ab	54.93abcd	51c	56c	1566c	1603.0b	58.34bcd	58.04bc
I ₂ N ₃	57.2ab	59.67a	50cd	51d	1510d	1556.0b	52.32cd	54.67d
I ₃ N ₀	52.4abcd	54.13abcd	45fg	47f	1348f	1379.0cd	35.27g	39.50h
I ₃ N ₁	55.4ab	56.93ab	54b	56c	1586c	1615.0b	55.32bc	60.69b
I ₃ N ₂	58.3a	59.80a	58a	63a	1726a	1838.0a	59.87a	64.65a
I ₃ N ₃	55.2abc	59.07a	55b	58b	1664b	1788.0a	55.73b	63.64a
CV (%)	12.4	14.5	13.7	12.8	15.4	12.8	12.8	7.6

Total water use

The total water use varied from 15.48cm to 31.20cm during 2003-04 and the highest water recorded in the IW: CPE ratio of 1.0 (Table 3). This treatment received 5 irrigations. But I₃ treatment displayed statistically identical yield with I₂ and received 4 irrigations with total water use of 31.20 cm. Tomato yield increased with the increase of irrigation based on IW: CPE ratio upto 0.6 to 1.0. The number of irrigation required for IW: CPE ratio of 0.6, 0.8 and 1.0 were 3, 4 and 5, respectively.

Table 4. Water use of tomato under different level of irrigation at Joydebpur during 2003-2004

Irrigation (IW:CPE)	No. of irrigation	Days to irrigation	Irrigation water applied (cm)	Soil moisture depletion (cm)	Rainfall (cm)	Total water use (cm)
Rainfed (I ₀)	-	-	0.0	14.60	0.88	15.48
I ₁ IW/CPE : 0.6	3	27,53,72	12.0	13.63	0.88	26.71
I ₂ IW/CPE : 0.8	4	14,38,62,75	16.0	12.22	0.88	29.10
I ₃ IW/CPE : 1.0	5	10,19,44,55,66	20.0	10.32	0.88	31.20

The total water use varied from 16.80cm to 32.81cm during 2004-05 and the highest water use recorded in the IW:CPE ratio of 1.0 (Table 4). This treatment received 5 irrigations. But I₃ treatment displayed statistically different yield with I₂ that received 4 irrigations with total water use of 32.81 cm. Tomato yield increased with the increase of irrigation based on IW: CPE ratio upto 0.6 to 1.0. The total number of irrigation at 0.6, 0.8, and 1.0 ratio came out to be 3, 4 and 5, respectively during the rabi season of 2003-04 and 2004-05.

Table 5. Water use of tomato under different level of irrigation at Joydebpur during 2004-2005

Irrigation (IW:CPE)	No. of irrigation	Days to irrigation	Irrigation water applied (cm)	Soil moisture depletion (cm)	Rainfall (cm)	Total water use (cm)
Rainfed (I ₀)	-	-	0.0	15.81	0.99	16.80
I ₁ IW/CPE : 0.6	3	29,55,74	12.0	14.88	0.99	27.79
I ₂ IW/CPE : 0.8	4	15,39,63,76	16.0	13.98	0.99	31.97
I ₃ IW/CPE : 1.0	5	11,20,45,57,68	20.0	11.82	0.99	32.81

From two year's result, it may be recommended that four times irrigation (15, 40, 60 and 75 days after planting) and 163.3 kg N ha⁻¹ are suitable for cultivation of tomato (BARI Tomato-9) in the Grey Terrace Soil of Bangladesh (AEZ-28).

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