Indian Journal of Agronomy **66** (1): 61–66 (March 2021)

Research Paper

Rice (*Oryza satiava*) straw mulch, irrigation and nitrogen effects on productivity and nitrogen-use efficiency of Bt cotton (*Gossypium hirsutum*) in subtropical environment

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Received: June 2020; Revised accepted: March 2021

ABSTRACT

A 2-years (2015 and 2016) field study was carried out at Ludhiana, Punjab, to examine the combined effects of residue mulch, irrigation frequency and nitrogen levels on productivity and nitrogen-use efficiency of Bt cotton (*Gossypium hersutum* L.) in a subtropical environment. Combination of mulch rates, *viz.* 0 (M_0) and 6 t/ha (M_6), and irrigation regimes, viz. irrigation water to pan evaporation ratio of 0.2 ($I_{0.2}$), 0.3 ($I_{0.3}$) and 0.4 ($I_{0.4}$), in main plots; and 4 Nitrogen (N) rates, viz. 0 (N_0), 50 (N_{50}), 100 (N_{100}) and 150 (N_{150}) kg/ha, in subplots were randomized with 3 replications. Mean seed-cotton yield was greater in mulch (3.8 t/ha) than in no-mulch (2.9 t/ha) treatment. Interaction effects of irrigation and N on seed cotton N uptake were significant. Mean seed cotton N uptake increased from 61.4 kg/ha in N_0 to 80.4 kg/ha in N_{150} in $I_{0.4}$ regime; while in $I_{0.2}$, uptake increased from 44.9 kg/ha in N_0 to 58.9 kg/ha in N_{150} in crop-growing season of 2015. Mulching enhanced this interaction by causing greaters uptake increase in $I_{0.2}N_{150}$ than in $I_{0.4}N_{150}$ regime. Comparable seed-cotton nitrogen uptake in $I_{0.2}M_6N_0$ (51.2 kg/ha) and $I_{0.4}M_0N_{150}$ (65.3 kg/ha) indicated that same N uptake could be realized with less water and nitrogen with mulching. Similar trend in crop-growing season of 2016 was observed. Similarly, nitrogen-use efficiency (5.8 and 6.1 kg seed cotton/kg N applied) was higher under rice-straw mulch than no-mulch treatment. Frequent irrigation regimes resulted in significantly higher seed-cotton yield (3.4 and 3.9 t/ha), total nitrogen uptake (142.4 and 150.3 kg/ha) over restricted irrigation regimes respectively. Among nitrogen rates, the highest nitrogen-use efficiency was observed in N_{50} level. Pooled analysis showed that $M_6I_{0.2}$ treatment had 10.7% higher seed-cotton yield than $M_0I_{0.4}$. Higher seed-cotton yield (3.4 t/ha) was recorded with M_6N_0 treatment than M_0N_{100} (3.1 t/ha). Results indicated that the rice-straw mulching saved 1 irrigation and N responses restricted up to 100 kg N/ha. With increase in N fertilization 9.6% gain in yield was noted in N_0 over N_{100} with mulching and it saved 50 kg N/ha with yield grain in Bt cotton.

Key words: Seed-cotton yield, Mulching, Irrigation, Nitrogen uptake, Nitrogen-use efficiency

Continuous rice cultivation in Northwest India has led to surplus rice straw production and alarming fall in groundwater table. Large scale on-farm burning of rice residue, intense air pollution and water scarcity demands an alternative option to replace rice in the rainy (*kharif*) season. Cotton the 'White gold' enjoys a predominant position amongst all cash crops in India. In India, it occupies an area of 10.5 million ha which is about 27% of the world. India has emerged as the second largest producer of cotton in the world after China with 35.45 million bales during 2016–17 and 2019–20 with an average productivity of 568 kg/ha (www.cotcorp.gov.in). Cotton crop supports about 60 million people directly and indirectly through its production, processing, marketing and trade in India. It is the main *kharif* crop of south-west region of Punjab in India. Increase in cotton production can be traced to the introduction of Bt cotton varieties. About 40% area is under recommended Bt cotton hybrids. Bt cotton being highly-exhaustive crop with regard to plant nutrients, fairly large quantities of nutrients are required (Rao and Setty, 2002). Nitrogen is one of the factors that directly influences vegetative growth and dry-matter production, and required in larger amounts than other nutrients for cotton production (Hou *et al.,* 2007). Nitrogen fertilization significantly affects plant growth, lint yields and fibre quality (Boquet *et al.,* 1993; Bondada *et al.,* 1996). Deficient N levels from emergence to early blooming could lead to inadequate vegetative growth, resulting in decreased fruiting (Gardner and Tucker, 1967), while nitrogen deficiency throughout the

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growing season will lead to decreased boll production as a result of poor plant development and premature senescence (Zhang *et al.,* 2012).

In contrast, an over-dose of N will promote excessive vegetative development and delay maturity (Hodges, 2002) and leads to environment threatening and groundwater pollution. Thus, application of optimum dose of nitrogen fertilizer is essential in the cotton for maximum yield. Improving synchronization between N supply and crop demand can lead to high N-use efficiency (Chen *et al.,* 2014). In north-western India, 150 kg N /ha for Bt and non-Bt hybrids and 75 kg N /ha for *desi* cotton at fixed growth stages of the crop is recommended. Among the different plant nutrients, nitrogen is widely considered one of the major essential nutrients for Bt cotton growth. The increased crop production under N application can be attributed to larger leaf-area index (LAI) and green crop duration (Barthwal *et al*., 2013). Therefore, there is need of rational use of N to optimize crop productivity and minimize the risk of N leaching. In view of the available surplus rice straw, lower nitrogen-use efficiency and declining watertable, there is a need to evolve a technique for improving cotton productivity and saving of irrigation water and N through cotton cultivation.

MATERIALS AND METHODS

The field experiment was conducted at the research farm of Punjab Agricultural University, Ludhiana (38°56' N, 75°52' E 247 m above mean sea-level) Punjab, India, during summer seasons of 2015 and 2016. The climate of this area is characterized as sub-tropical and semi-arid with hot and dry summer from April to June, hot and humid from July to September and cold winter from November to January. The average annual rainfall is 500–750 mm, most of which is received during the monsoon period from July to September. The cotton-growing season extends from May to October, maximum temperature of 45°C is common during summer and freezing temperature of 1 to 2°C accompanied by frost is also quite common from December to January. Mean maximum and minimum temperature showed considerable fluctuations during summer and winter months. During crop season monthly maximum temperature of 39.9°C and 39.5 °C was recorded in May and minimum temperature of 19.0°C and 19.1°C in October 2015 and 2016 respectively. Total rainfall received during the cotton-growing season was 542.1 and 529.9 mm with maximum rain of 256.1 and 305.5 mm in July in 2015 and 2016. The mean sunshine varied from 0.3 to 12.2 hr/day and 1–13 hr/day during crop-growing season in 2015 and 2016.

The soil of the experimental site was deep alluvial sandy loam in texture, developed under hyperthermic regimes. The top 0–15 cm layer of the soil profile was neutral in pH_2 (7.6), with 0.11 dS/ m electrical conductivity (EC_2), low in $KMnO_4$-oxidizable N (182.4 kg/ha) and Walkley and Black organic carbon (0.40%), medium in Olsen-P (24.3 kg/ha) and 1 N NH_4OAc-extractable K (134.8 kg/ha). The data collected on various soil physico-chemical properties are presented in Table 1.

The experiment was laid out in split-plot design, keeping combination of 3 irrigation regimes of 0.2, 0.3 and 0.4 (based on IW : PAN-E ratios) and 2 rates of rice residue mulch (0 and 6 t /ha) in main plots and 4 nitrogen rates (control, 50, 100 and 150 kg/ha) in subplots and replicated three times. The experiment was conducted in gross plot of 6.3 m × 3.7 m size and net size of plot was 6.0 m × 3.4 m. The experiment was established on same location and treatments were imposed on same plots in both the years of study. As per recommendations crop was fertilized with 30 kg P_2O_5 /ha through single superphosphate, 50 kg K_2O/ha through muriate of potash and 25 kg/ha for Zn as zinc sulphate heptahydrate as basal dose. Half of nitrogen (urea) as per treatment was applied basal and remaining half N as per treatment was applied 85 days after sowing (flowering) flower initiation. The differential irrigation was started after sowing as per treatments based on IW : PAN-E ratio. Parshall flumes were used to apply the measured known amount (70 mm) of irrigation water. The rates of rice straw

Table 1. Physical and chemical properties of the experimental soil

Soil depth (m)	Sand (%)	Clay (%)	Textural Class	BD (g/cm³)	pH_2	EC_2 (dS/m)	Organic carbon (%)	Nutrient available (Kg/ha) N	P	K
0–0.15	55	13	Sandy loam	1.43	7.6	0.11	0.40	135	182	24
0.15–0.30	60	12	Sandy loam	1.46	8.2	0.07	0.39	134	181	24
0.30–0.60	63	10	Sandy loam	1.52	8.2	0.05	0.35	125	164	23
0.60–0.90	68	9	Sandy loam	1.62	8.5	0.05	0.33	122	152	21
0.90–1.20	71	8	Loamy sand	1.69	8.5	0.02	0.25	110	148	10
1.20–1.50	73	7.9	Loamy sand	1.69	8.5	0.08	0.22	102	140	8.2
1.50–1.80	77	5	Loamy sand	1.72	8.3	0.05	0.18	140	8.0	102

BD, Dry bulk density; EC electrical conductivity mulch included: no mulch (M_0) and 6 t (M_6) rice straw/ha. Chopped rice straw of size 15–20 cm was applied as mulch manually on the same day after sowing of Bt cotton in each year. At proper moisture conditions of field, fine seed-beds were prepared by 2 cultivation with a tractor-drawn cultivator each followed by planking. Bt cotton variety 'Ankur 3028 BG II' was planted on 6 May 2015 and 9 May 2016. Bt cotton seeds were sown manually at 67.5 cm row-to-row and 75 cm plant-to-plant spacing at 5 cm depth. Seeds were treated with 0.5 g Emisan-6 and 0.2 g of streptocycline for 1 kg cotton seed in 1 litre of water. The crop was harvested by picking at different maturity stages of cotton crop.

Leaf-nitrogen content was estimated at 40 and 80 days after sowing (DAS) and at harvesting by Kjeldhal's method. At 40 and 80 DAS, leaves were selected from 5 plants (base to top) per plot and then these leaves were air-dried followed by oven-drying. After complete drying leaves were grind by mechanical grinder and 1 g grinded, plant sample was used for determination of nitrogen content. At harvesting time for nitrogen determination, the whole plant was was cut down into small pieces and 1 g oven-dried and grounded plant sample was used for nitrogen determination. Nitrogen-use efficiency (NUE) and apparent nitrogen recovery were calculated as:

Nitrogen-use efficiency=Seed-cotton yield (SCY) in fertilized plot–SCY in control)/ Applied nitrogen

Apparent nitrogen recovery=Nitrogen uptake (NU) in fertilized plot – NU in control/ Applied nitrogen

RESULTS AND DISCUSSION

Leaf nitrogen content

Dilution effect leads to decrease in N content with increase in age of plant. Treatment effect on leaf N content at 40 and 80 DAS (Table 2) showed that individual effect of irrigation was significant during both crop growing season (2015 and 2016) at 40 DAS, mulch and nitrogen had significant effect in 2016 crop-growing season only (40 DAS). On an average of 2 seasons, with increase in irrigation frequency from $I_{0.2}$ to $I_{0.4}$, leaf N content increased from 3.22 to 3.5% (40 DAS) and 2.25 to 2.42% (80 DAS) mainly owing to the more application of nitrogen at N_{150} over N_0 treatment. Mulch application increased 3.3% N content over no mulch in 2016 crop growing season (40 DAS). With N fertilizer application, N content increased 7.3% from N_0 (3.15%) to N_{150} (3.38%) at 40 DAS in 2016 season. Averaged over 2 years, increase in leaf N content was 2.2 to 2.5% from N_0 to N_{150} (80 DAS).

Seed cotton and biomass nitrogen content

Treatment effect on seed-cotton and biomass N content is given in Table 2. Different N treatments had significant effect on seed cotton and biomass N content. Nitrogen response was restricted to 100 kg N/ha and with the increase in N doses from 100 to 150 kg N/ha, there was no gain in N content. Averaged over years, with application of fertilizer N from N_0 to N_{100} gain in seed-cotton N content was from 0.018 to 0.022 kg/kg and 0.09 to 0.012 kg/kg in biomass N content.

Table 2. Effect of irrigation scheduling, rice-straw mulch and nitrogen

Treatment	Leaf-N content (%) 40 DAS		Leaf-N content (%) 80 DAS		Seed cotton N content, (kg/kg) at harvesting		Biomass N content (kg/kg) at harvesting	
	2015	2016	2015	2016	2015	2016	2015	2016
Irrigation scheduling								
$I_{0.2}$	3.26	3.18	2.28	2.21	0.019	0.018	0.009	0.011
$I_{0.3}$	3.39	3.30	2.43	2.28	0.021	0.020	0.012	0.011
$I_{0.4}$	3.58	3.42	2.60	2.23	0.023	0.021	0.014	0.012
CD (P=0.05)	0.15	0.12	0.16	NS	0.0014	NS	0.001	NS
Mulch								
M_0	3.41	3.24	2.42	2.22	0.020	0.019	0.011	0.010
M_6	3.43	3.35	2.44	2.27	0.021	0.020	0.013	0.011
SEm±								
CD (P=0.05)	NS	0.09	NS	NS	NS	NS	0.001	NS
N (kg/ha)								
N_0	3.28	3.15	2.28	2.07	0.019	0.017	0.010	0.009
N_{50}	3.37	3.29	2.39	2.20	0.019	0.019	0.011	0.010
N_{100}	3.49	3.36	2.50	2.34	0.022	0.021	0.013	0.011
N_{150}	3.52	3.38	2.54	2.42	0.022	0.021	0.012	0.013
SEm±								
CD (P=0.05)	NS	0.16	0.18	0.17	0.0015	0.001	0.001	0.0008

Details of treatments are given under Materials and Methods; DAS, Days after sowing

Nitrogen uptake

Treatment effects on seed-cotton yield and N uptake (Table 3) were similar. Averaged over 2 years, seed-cotton yield data for 2 seasons showed that mean yield was greater in 2016 (3.6 t /ha) than in 2015 (3.1 t /ha) partty due to differences in weather conditions. Interaction effects of irrigation and N or mulch and N on seed-cotton yield were significant. Averaged over years, irrigation and nitrogen regimes, mulch application enhanced 31.0% seed-cotton yield over no mulch. Comparable seed-cotton yield in $I_{0.2}M_6N_0$ and $I_{0.4}M_0N_{150}$ (3.07 t /ha) indicated that, same yield could be realized with less water and nitrogen with mulching. Kaur and Brar (2016) also found significant interactive effects of irrigation regimes and mulching on turmeric yield. Higher seed cotton yield (3.4 t /ha) was recorded with M_6N_0 treatment as compared to M_0N_{100} (3.1 t/ ha). Patel *et al* (2004) also revealed that, 160 kg N/ha increased the cotton yields significantly over 80 kg N/ha and also reported that more than 160 kg N/ha was not beneficial. In 2015, increase in N from N_0 to N_{100} regimes in $I_{0.2}$ increased the N uptake from 38.5 to 50.0 kg/ha in M_0; and from 51.2 to 70.6 kg/ha in M_6 treatment and also greater N uptake in M_6N_0 (60 kg/ha) than M_0N_{150} (55.3 kg/ha) treatments. In 2016, trends of N uptake responses to treatments were similar. Higher biomass N uptake (Table 4) was noted in $M_6I_{0.2}$ (50.8 kg/ha in 2015 and 55.6 kg/ha in 2016) as compared to $M_0I_{0.4}$ (49.9 kg/ha in 2015 and 51.1 kg/ha in 2016). Greater biomass N uptake in M_6N_0 (52.3 kg/ha) than M_0N_{150} (45.2 kg/ha) in 2015. Similar trend for treatment effects on biomass N uptake was observed. Bandyopadhyay *et al.* (2009) observed that mulching led to greater N uptake in cotton, resulting in less harvest-time NO_3-N in the soil profile. Greater increase in N uptake with increasing N in $I_{0.4}$ than in $I_{0.2}$ in both the cropping seasons indicates significant synergistic effects that endorse earlier reports on rainy season maize (Lenka *et al.,* 2013). Averaged over irrigation and mulching, seed-cotton N uptake increased with the increase in fertilizer N dose 57.8 (N_0) to 73.7 kg/ha (N_{100}). Shivay and Singh (2003) reported that, rice grain and straw and total N uptake increased significantly with levels of N owing to production of higher amount of biomass. Diwedi and Thakur (2000) also reported similar results.

Nitrogen-use efficiency

Nitrogen-use efficiency (NUE) of any crop depends upon 2 factors: yield of that crop and amount of nitrogen applied. In 2015, NUE of $I_{0.4}$ and $I_{0.3}$ irrigation regimes was 37.0% higher than $I_{0.2}$ irrigation regimes and NUE in $I_{0.4}$ and $I_{0.3}$ was similar (Table 5). With the application of crop-residue mulch, nitrogen-use efficiency of mulch plot was 100% higher than no-mulch plots. The NUE of N_{50} was higher than N_{100} and N_{150} nitrogen rates and it was 148% higher in N_{50} as compared to N_{150}. Pradhan *et al*. (2014) also reported similar results and found that partial factor productivity of nitrogen (PFPN) was significantly lower in N_{120} treatment than N_{60}. The decrease in PFPN with the increase in nitrogen doses may be attributed to the fact that with increase in N levels there was increase in the losses of nitrogen through leaching, volatilization and deep percola-

Table 3. Treatment responses to N nitrogen uptake by seed-cotton

	N uptake by seed cotton, kg/ha							
	2015				2016			
	N_0	N_{50}	N_{100}	N_{150}	N_0	N_{50}	N_{100}	N_{150}
Mulch and irrigation regimes								
$M_0I_{0.2}$	38.5	41.1	50.0	45.0	42.6	51.0	55.8	57.4
$M_0I_{0.3}$	42.1	44.6	57.3	55.7	48.3	54.9	65.0	62.0
$M_0I_{0.4}$	51.7	62.7	67.6	65.3	54.6	69.5	68.8	72.6
$M_6I_{0.2}$	51.2	58.3	70.6	72.7	53.1	64.8	75.6	72.2
$M_6I_{0.3}$	57.6	67.1	79.4	81.6	63.9	72.0	98.2	93.6
$M_6I_{0.4}$	71.1	89.4	95.1	95.4	67.0	98.8	101.2	104.7

Factor Mean	Year 2015 = 63.0; 2016 = 69.5
	Mulch M_0 = 55.2; M_6 = 77.3
	Irrigation $I_{0.2}$ = 56.0; $I_{0.3}$ = 65.2; $I_{0.4}$ = 77.0
	Nitrogen N_0 = 57.8; N_{50} = 64.5; N_{100} = 73.7; N_{150} = 73.0
LSD (P = 0.05)	Year = 1.2
	Mulch = 8.0
	Irrigation = 8.0
	Nitrogen = 2.9
	Irrigation × Mulch = 5.0 Mulch × Nitrogen = 5.0

Details of treatments are given under Materials and Methods tion. In 2016, NUE of $I_{0.4}$ and $I_{0.3}$ irrigation regimes was similar and 31.6 % higher than $I_{0.2}$ irrigation regimes. With the application of crop-residue mulch, nitrogen-use efficiency of mulch plot was 103% higher than no mulch plots and NUE of N_{50} was higher than N_{100} and N_{150} nitrogen rates and it was 148% higher in N_{50} as compared to N_{150}. The NUE in mulched and no-mulch plots was higher in N_{50} treatment as compared to N_{100} and N_{150} treatment. Higher NUE in N_{50} nitrogen rate was mainly owing improvement in seed-cotton yield per unit added nitrogen was more than corresponding increase with 100 and 150 kg/ha.

Apparent nitrogen recovery efficiency

Apparent nitrogen recovery efficiency (ANRE) of Bt cotton was higher under $I_{0.4}$ irrigation regimes than to $I_{0.3}$ and $I_{0.2}$ and lowest in $I_{0.2}$ irrigation regimes and also higher with mulched plot (Table 6). In 2015, ANRE was 79.1% higher under $I_{0.4}$ irrigation regimes over $I_{0.2}$ irrigation regimes. With the application of mulch, 87.1% higher ANRE was observed than no-mulch plots. The ANRE was the highest in N_{100} and the lowest in N_{150} treatment and it was 56.5% higher in N_{100} over N_{150}. In 2016, the ANRE was the higher under $I_{0.4}$ irrigation regimes as compared to $I_{0.3}$ and $I_{0.2}$ and was recorded lowest in $I_{0.2}$ irrigation regimes and it was 82.3% higher in $I_{0.4}$ irrigation regimes over $I_{0.2}$ irrigation regimes. Mulching enhanced ANRE 86.7% over no-mulch plots. The ANRE in N_{50} was the highest over N_{100} and N_{150} treatment and the lowest was recorded in N_{150} treatment.

It was observed that there was a significant increase in seed-cotton yield and nitrogen uptake but decrease in nitrogen-use efficiency with the increase in N levels during both crop-growing seasons. Seed-cotton yield was the highest in between 90 and 100 kg/ha nitrogen dose, thereafter it was diminished with the increase in N level. Mulching saved the nitrogen in the crop and also improved nitrogen-use efficiency of Bt cotton crop. Optimum nitrogen rate was found 100 kg /ha as compared to 150 kg/ha.

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Table 4. Effect of irrigation, mulch and nitrogen on N uptake by biomass in Bt cotton

Mulch and irrigation regimes	N uptake by biomass, kg/ha 2015 N_0	N_{50}	N_{100}	N_{150}	2016 N_0	N_{50}	N_{100}	N_{150}
$M_0I_{0.2}$	23.9	27.6	38.2	32.5	22.7	31.8	37.5	47.3
$M_0I_{0.3}$	29.3	34.2	46.4	40.7	32.0	39.7	47.7	55.7
$M_0I_{0.4}$	38.4	42.1	56.6	62.4	35.3	45.5	59.8	63.7
$M_6I_{0.2}$	36.3	45.4	58.6	63.0	37.0	51.7	61.2	68.5
$M_6I_{0.3}$	55.2	69.8	78.3	73.9	51.1	69.6	78.5	80.0
$M_6I_{0.4}$	65.4	84.0	98.2	93.3	60.7	92.4	96.3	119.1

Factor Mean: Year 2015 = 53.9; 2016 = 57.7; Mulch M_0 = 41.3; M_6 = 70.3
Irrigation $I_{0.2}$ = 42.7; $I_{0.3}$ = 55.1; $I_{0.4}$ = 69.0; Nitrogen N_0 = 40.6; N_{50} = 52.8; N_{100} = 63.1; N_{150} = 66.7
LSD (p = 0.05): Year = 1.4; Mulch = 11.0
Irrigation = 8.0; Nitrogen = 5.0
Irrigation × Mulch = 2.0; Mulch × Nitrogen = 5.0

Table 5. Effect of treatment on NUE of Bt cotton

	NUE, kg seed cotton kg/N 2015 N_{50}	N_{100}	N_{150}	2016 N_{50}	N_{100}	N_{150}
Mulch and irrigation regimes						
$M_0I_{0.2}$	2.8	3.7	1.6	3.0	4.1	1.4
$M_0I_{0.3}$	4.4	3.9	1.7	4.2	4.0	1.7
$M_0I_{0.4}$	4.0	3.1	1.1	3.8	3.2	1.1
$M_6I_{0.2}$	5.6	4.0	3.1	5.6	5.3	3.1
$M_6I_{0.3}$	10.0	5.8	3.7	9.6	6.5	3.6
$M_6I_{0.4}$	10.6	6.0	3.7	10.8	6.3	3.8

Factor Mean: Mulch M_0 = 2.9; M_6 = 5.8; Mulch M_0 = 3.0; M_6 = 6.1
Irrigation $I_{0.2}$ = 3.5; $I_{0.3}$ = 4.9; $I_{0.4}$ = 4.8; Irrigation $I_{0.2}$ = 3.8; $I_{0.3}$ = 5.0; $I_{0.4}$ = 4.9
Nitrogen N_{50} = 6.2; N_{100} = 4.5; N_{150} = 2.5; Nitrogen N_{50} = 6.2; N_{100} = 4.9; N_{150} = 2.5

Table 6. Effect of treatment on apparent nitrogen recovery efficiency (ANRE) of Bt cotton

Mulch and irrigation regimes	ANRE					
	2015			2016		
	N_{50}	N_{100}	N_{150}	N_{50}	N_{100}	N_{150}
$M_0I_{0.2}$	5.2	11.5	4.3	16.8	13.2	9.9
$M_0I_{0.3}$	5.0	15.2	9.1	3.2	16.7	9.1
$M_0I_{0.4}$	22.0	15.9	9.0	29.8	14.2	12.0
$M_6I_{0.2}$	14.2	19.4	14.3	23.4	22.5	12.7
$M_6I_{0.3}$	19.0	21.8	16.0	16.2	34.3	19.8
$M_6I_{0.4}$	36.6	24.0	16.2	63.6	34.2	25.1

Factor Mean
Mulch M_0 = 15.0; M_6 = 28.0 Irrigation $I_{0.2}$ = 16.4; $I_{0.3}$ = 18.2; $I_{0.4}$ = 22.9
Mulch M_0 = 10.8; M_6 = 20.2 Nitrogen N_{50} = 27.2; N_{100} = 22.5; N_{150} = 14.8
Irrigation $I_{0.2}$ = 11.5; $I_{0.3}$ = 14.4; $I_{0.4}$ = 20.6 Nitrogen N_{50} = 17.0; N_{100} = 18.0; N_{150} = 11.5

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