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# Irrigation and N-use Efficiency of Cotton Cultivar MNH554 Under Multan Conditions

Mahmood-ul-Hassan, Taj Muhammad, Saeed Ahmad,
Muhammad Iqbal, Abdul Karim and Muhammad Yousaf Akhtar
Cotton Research Station, Multan, Pakistan

**Abstract:** To explore N- use efficiency of MNH554 a tetraploid cotton (*Gossvpium hirsutum* L.) in relation to various irrigation regimes, a three year project was launched in 1998 under agro-ecological conditions prevailing at Multan. The experiment was seeded in the open field during the normal growing season, with pure and true to type seed of variety MNH554. Four nitrogen doses and three irrigations regimes were applied to the crop. In addition, the crop had also received 56 kg P $ha^{-1}$ and 55 kg K $ha^{-1}$ as a basal dose. Growth and development characteristics comprising of height of the plant, number of mature bolls per plant, boll weight, yield of seed cotton and ginning outturn were studied. Plant height, bolls per plant, boll weight and yield of seed cotton registered a positive and significant response to increasing doses of nitrogen and irrigation. On an average of three years, the maximum yield of 4105 kg $ha^{-1}$ of seed cotton was obtained by 168 kg N $ha^{-1}$ with seven irrigations, well distributed throughout the growth and development period. Nitrogen and irrigation application did not improve the ginning outturn, rather it ensued a slight drop.

**Key words:** Boll weight, boll mass, fibre content, ginning outturn, *Gossypium hirsutum* L., irrigation, N-efficiency, nitrogen, seed cotton

## Introduction

Cotton is the most important textile fibre crop and is second most important oilseed crop in the world (Chary and Leffler, 1984 ) and is also one of the most important crops of Pakistan, which accounts for 60% of total foreign exchange earnings through export of lint and value added cotton products (Anonymous, 1999-2000). The seed cotton production per unit area is affected by the following factors i.e., genotype, plant population, time of sowing, soil status, environmental conditions (temperature, rainfall, humidity) and insect infestation (Afzal and Ali, 1983). Placing Pakistan in the international perspective, the yield per hectare is far below. The main reason for low production is lack of exploitation of the genetic potential that a variety has embodied in the seed. There exist an ample scope and potential, that Pakistan should achieve through the judicial use of inputs and adoption of latest package of production technology. The balanced use of fertilizer, optimum time of application and suitable irrigation regime can help achieving the goals (Khan *et al.,* 1994). The important factors responsible for increasing cotton yields were analyzed by Ali (1972) who reported yield increase by ensuring sufficient water supply to the acreage which use to suffer due to various supply of irrigation water at sowing and later stages and increased use of fertilizer. He further estimated that 40% of the increase in yield was due to each of irrigation and fertilizer.

Cotton plant demands irrigation at regular intervals throughout the growth and development period for producing good yields and better fiber (Boquet *et al.*, 1986; Bordovsky and Lyie, 1986; Malik and Choudhry, 1992; Khan *et al.*, 1993, 1994). Adequate supplies of irrigation and nitrogen have been found increasing the plant height, number of boll per plant, boll weight and seed cotton yields (Dhonde, 1985; Bharadwaj *et al.*, 1986; Howard and Haskinson, 1986; Khan, *et al.*, 1993., 1994). Sawan (1986) pointed out that number of mature bolls per plant, boll weight, seed index and lint yield per hectare increased with increasing doses of nitrogen.

The purpose of this study was to check the specific response of MNH554, a tetraploid cotton variety to different doses of nitrogen and irrigation and to find out the most suitable combination of the two.

## Materials and Methods

The experiment was conducted at Cotton Research Station Multan during 1998 to 2000 on cotton variety MNH554. Three irrigation regimes Wl (Three irrigations on 20/7, 12/8, 5/9), W2 (Five irrigations on 20/7, 12/8, 5/9, 15/9, 5/10) and W3 (seven irrigations on 20/7,12/8, 5/9, 15/9, 5/10, 15/10 and 25/10) and four nitrogen levels i.e.,N1 (0 kg N $ha^{-1}$, N2 (56 kg N $ha^{-1}$), N3 (112 kg N $ha^{-1}$) and N4 ( 168 kg N $ha^{-1}$) were tested in split plot design having four replications on a plot size of 6.7x3 $m^2$.

Moreover, 57 kg P $ha^{-1}$ and 57 kg K $ha^{-1}$ was applied as a basal dose. The crop was sown on 1.6.1998, 29.5.1999 and 30.5.2000 on well prepared seed bed, under field

conditions with a single row hand drill keeping plant rows at 75 cm apart, one-third of the total N of each treatment was applied with the 1st irrigation and the remaining 2/3 with, the 2nd and 3rd irrigation. The observations were recorded about plant height, bolls per plant, boll weight, yield per hectare and ginning outturn.

The plant height was recorded from ground level to the top of the main axis on normally growing 10 connectively selected plants, which were also used for counting the number of bolls per plant. The bolls were counted, weighed and data were recorded. The seed cotton was hand picked and weighed for each treatment for plot yields and the plot yields were converted to seed cotton kg $ha^{-1}$. A 500 g sample was taken for laboratory tests. The data were subjected to analysis of variance and to discriminate the superiority of treatment means, Duncan multiple range test was applied following Gomez and Gomez (1984) procedures.

## Results and Discussion

**Plant height:** The data revealed that MNH554 plants in 1998 and 1999 gained the maximum plant height (119.7 and 106.8 cm) under maximum inputs conditions i.e., 168 kg N $ha^{-1}$ with seven irrigations, whereas in 1999 the maximum figure was 123.0 cm, produced by N 112 kg N $ha^{-1}$ with seven irrigations. The differences among the years were significant. On the average of three years the maximum plant height of 115.8 cm was obtained by 168 kg N $ha^{-1}$ with seven irrigations, followed by 113.8 cm with 112 kg N $ha^{-1}$ and seven. The lowest height of 98.3 cm was acquired by 0 kg N $ha^{-1}$ with five irrigations (Table 1). The plant height showed increasing trends with every increase in nitrogen and irrigation.

Among the irrigations levels, seven irrigations gave the maximum plant height (110.0 cm), followed 107.1 cm, recorded with three irrigations, whereas the lowest figure was 106.7 cm produced by five irrigations. Although some increase in plant height was noticed in response to irrigations but the differences among the irrigation levels remained non-significant.

In case of nitrogen levels, 168 kg N $ha^{-1}$ gave the maximum plant height (113.2 cm), followed by 112 kg N $ha^{-1}$ (112.7 cm), which was significantly higher than 56 and 0 kg N $ha^{-1}$ with 105.9 and 100.1 cm plant height, respectively. The differences among the nitrogen levels were highly significant. MNH554 cotton seems more responsive to N application as it showed increase in plant height with every increase in N level from NO to N4 (0 to 168 kg N $ha^{-1}$) even under the same irrigation regime. These results are in conformity with those of Bharadwaj *et al*. (1986), Sawan (1986) and Khan *et al.* (1993, 1994) who reported that with increasing N rate the plant height was increased. The interaction between irrigation x nitrogen was non-significant.

**Bolls per plant:** The results exhibit a uniform response of MNH554 plants for bearing maximum number of bolls per plant i.e., 24.6, 33.8 and 32.5, respectively during 1998, 1999 and 2000 under highest input treatments (W3N4:168 kg N $ha^{-1}$ and seven irrigations. The number of bolls per plant produced by N1W1 (0 kg N $ha^{-1}$ and 3 irrigations) was among the lowest in all the three years. The variety looks remarkably stable for fruit bearing as the differences among the years were non significant. On the average of three years the maximum bolls per plant (30.3) were recorded by 168 kg N $ha^{-1}$ with seven irrigations, whereas the lowest boll number (13.4) was noticed under the lowest input conditions (0 kg N $ha^{-1}$ + three irrigations).

Scanning the irrigation regimes, seven irrigations were found producing the maximum bolls per plant (22.4), followed by five irrigations (18.8 bolls), against 17.0 bolls per plant, which was the lowest figure obtained by three irrigations. There was significant difference among the three irrigation levels (Table 1).

The data on nitrogen levels reveal that 168 kg N $ha^{-1}$ gave the maximum bolls per plant (24.4), closely followed by 112 kg N $ha^{-1}$ with 21.7 bolls. The lowest bolls per plant 14.2) were recorded with 0 kg N $ha^{-1}$. The differences among the nitrogen levels were highly significant. This may be attributed to increased flower bud production, reflecting enhanced meristemetic activity, which resulted in more mature bolls per plant (Sawan, *et al.,* 1989). It is clear from the results that there was almost a linear increase in bolls per plant with increase doses of nitrogen and irrigation. Similar results were reported by Bharadwaj *et al*. (1986), Sawan (1986) and Khan *et al.* (1993, 1994). The interaction between years X irrigation, years x nitrogen, irrigations x nitrogen and years x irrigation x nitrogen was significant.

**Boll weight:** The data revealed that during the years 1998 through 2000, 168 kg N $ha^{-1}$ with seven irrigations gave the highest boll weight of 4.2, 4.4 and 4.4 g, respectively (Table 1). The lowest boll weights in the respective years were 3.5, 3.2 and 3.2 g accomplished by the smallest doses of irrigation and nitrogen (W1N1). A look on three years combined data displays the same trend that the highest boll weight (4.3 g) was obtained by the principal doses (W3N4) and the lowest by the minimal doses (W1N1). The variety again maintained its genetic stability by producing virtually the same boll mass over years, as the differences among the years were non- significant.

Considering the irrigation levels, the boll weight increased considerably with increased irrigation. Seven irrigations produced the maximum boll weight (4.0 g) followed by five

Table 1: Means of data on irrigation/fertilizer studies on MNH554 at Cotton Research Station, Multan from 1998 to 2000

| Y | W | N | Height (cm) | Bolls plant$^{-1}$ | Boll weight (g) | Yield kg ha$^{-1}$ | Ginning outturn (%) |
|---|---|---|---|---|---|---|---|
| 1 | | | 107.5 | 19.2 | 3.7 | 3179 | 43.0 |
| 2 | | | 100.5 | 19.0 | 3.7 | 2929 | 42.9 |
| 3 | | | 115.9 | 20.0 | 3.7 | 2683 | 43.0 |
| | 1 | | 107.1 | 17.0 | 3.5 | 2652 | 43.1 |
| | 2 | | 106.7 | 18.8 | 3.7 | 2961 | 43.0 |
| | 3 | | 110.0 | 22.4 | 4.0 | 3178 | 42.9 |
| | | 1 | 100.1 | 14.2 | 3.5 | 2020 | 43.2 |
| | | 2 | 105.9 | 17.3 | 3.6 | 2547 | 43.1 |
| | | 3 | 112.7 | 21.7 | 3.8 | 3360 | 43.0 |
| | | 4 | 113.2 | 24.4 | 4.0 | 3795 | 42.6 |
| | 1 | 1 | 99.1 | 13.4 | 3.3 | 1794 | 43.3 |
| | 1 | 2 | 105.3 | 16.6 | 3.5 | 2363 | 43.5 |
| | 1 | 3 | 112.3 | 18.6 | 3.6 | 3044 | 43.0 |
| | 1 | 4 | 111.8 | 19.3 | 3.7 | 3407 | 42.5 |
| | 2 | 1 | 98.3 | 13.7 | 3.4 | 2073 | 43.4 |
| | 2 | 2 | 104.7 | 16.9 | 3.6 | 2548 | 42.9 |
| | 2 | 3 | 111.8 | 21.0 | 3.8 | 3351 | 43.1 |
| | 2 | 4 | 112.1 | 23.6 | 4.0 | 3872 | 42.4 |
| | 3 | 1 | 102.7 | 15.5 | 3.6 | 2191 | 43.0 |
| | 3 | 2 | 107.7 | 18.4 | 3.7 | 2731 | 42.8 |
| | 3 | 3 | 113.8 | 25.4 | 3.8 | 3685 | 42.8 |
| | 3 | 4 | 115.8 | 30.3 | 4.3 | 4105 | 42.9 |
| 1 | 1 | 1 | 94.7 | 15.2 | 3.5 | 1774 | 43.2 |
| 1 | 1 | 2 | 100.6 | 18.3 | 3.7 | 2551 | 43.7 |
| 1 | 1 | 3 | 118.4 | 19.7 | 3.8 | 3535 | 42.7 |
| 1 | 1 | 4 | 115.4 | 19.9 | 3.8 | 3762 | 42.5 |
| 1 | 2 | 1 | 91.7 | 14.2 | 3.5 | 1884 | 43.5 |
| 1 | 2 | 2 | 101.2 | 17.6 | 3.7 | 2740 | 43.5 |
| 1 | 2 | 3 | 114.0 | 21.5 | 3.9 | 3840 | 42.8 |
| 1 | 2 | 4 | 113.8 | 23.1 | 4.1 | 4345 | 43.0 |
| 1 | 3 | 1 | 100.9 | 15.1 | 3.7 | 2037 | 42.8 |
| 1 | 3 | 2 | 106.3 | 18.3 | 3.8 | 2798 | 42.8 |
| 1 | 3 | 3 | 113.2 | 23.1 | 3.9 | 4327 | 43.0 |
| 1 | 3 | 4 | 119.7 | 24.6 | 4.2 | 4554 | 42.9 |
| 2 | 1 | 1 | 90.8 | 11.4 | 3.2 | 2030 | 43.2 |
| 2 | 1 | 2 | 95.1 | 15.2 | 3.4 | 2349 | 43.5 |
| 2 | 1 | 3 | 99.5 | 18.3 | 3.5 | 3126 | 43.3 |
| 2 | 1 | 4 | 101.2 | 20.3 | 3.7 | 3462 | 42.5 |
| 2 | 2 | 1 | 96.8 | 13.6 | 3.4 | 2263 | 42.7 |
| 2 | 2 | 2 | 101.1 | 16.3 | 3.6 | 2679 | 43.2 |
| 2 | 2 | 3 | 106.2 | 18.8 | 3.8 | 3034 | 43.0 |
| 2 | 2 | 4 | 103.3 | 20.5 | 3.9 | 3609 | 42.0 |
| 2 | 3 | 1 | 98.0 | 14.8 | 3.6 | 2226 | 43.1 |
| 2 | 3 | 2 | 101.9 | 18.0 | 3.7 | 2813 | 42.9 |
| 2 | 3 | 3 | 105.3 | 26.6 | 4.3 | 3407 | 43.1 |
| 2 | 3 | 4 | 106.8 | 33.8 | 4.4 | 4153 | 42.5 |
| 3 | 1 | 1 | 111.9 | 13.5 | 3.2 | 1578 | 43.6 |
| 3 | 1 | 2 | 120.1 | 16.3 | 3.4 | 2190 | 43.5 |
| 3 | 1 | 3 | 118.7 | 17.8 | 3.6 | 2471 | 43.0 |
| 3 | 1 | 4 | 118.9 | 17.7 | 3.6 | 2997 | 42.7 |
| 3 | 2 | 1 | 106.5 | 13.4 | 3.3 | 2073 | 44.0 |
| 3 | 2 | 2 | 111.7 | 16.9 | 3.6 | 2226 | 42.1 |
| 3 | 2 | 3 | 115.3 | 22.8 | 3.7 | 3180 | 43.5 |
| 3 | 2 | 4 | 119.3 | 27.3 | 4.1 | 2664 | 42.3 |
| 3 | 3 | 1 | 109.3 | 16.8 | 3.3 | 2312 | 43.0 |
| 3 | 3 | 2 | 114.8 | 19.0 | 3.8 | 2581 | 42.7 |
| 3 | 3 | 3 | 123.0 | 26.5 | 4.1 | 3321 | 42.3 |
| 3 | 3 | 4 | 120.8 | 32.5 | 4.4 | 3609 | 43.3 |

Y=year W= Irrigation N= Nitrogen

irrigations (3.7 g), whereas the lowest boll weight was 3.5 g noticed with three irrigations. The differences among the irrigation levels were highly significant. Amongst the nitrogen levels, the highest boll weight (4.0 g) was obtained by 168 kg N $ha^{-1}$ followed by 3.8, 3.6, and 3.5 g produced by 112, 56 and 0 kg N $ha^{-1}$, respectively.

The increase from N fertilization may be due to increased photosynthetic activity causing higher accumulation of metabolites, with direct impact on boll weight (Sawan *et al.*, 1989, Khan *et al.*, 1993,1994). The differences among the nitrogen levels were highly significant. It is clear from the results that the reaction of MNH-554 to enhanced doses of N application and irrigation was positive. Specially the increase on account of N application seems more pronounced. These results are in conformity with that of Sawan (1986) and Khan *et al.*, 1993, 1994).The interaction between years x irrigation, years x nitrogen, irrigations x nitrogen and years x irrigation x nitrogen was significant.

**Yield of seed cotton:** The data given in (Table 1) demonstrate that during 1998, 1999 and 2000, the maximum yields of 4554, 4153, and 3609 kg $ha^{-1}$ of seed cotton were picked from the crop of 168 kg N $ha^{-1}$ and seven irrigations, except for 2000 when it was with five irrigations.

During the three years the lowest yields were recorded in 0 kg N $ha^{-1}$ with three irrigations. The differences among the years were highly significant. On the average of three years the maximum yield of 4105 kg $ha^{-1}$ of seed cotton was produced by 168 kg N $ha^{-1}$ with seven irrigations as compared to the lowest yields of 1794 kg $ha^{-1}$ produced by the lowest input level of irrigation and nitrogen (W1N1).

In case of irrigation regimes, seven irrigations produced the highest seed cotton yield of 3178 kg $ha^{-1}$, followed by five irrigations, 2961 kg $ha^{-1}$, which was significantly higher than three irrigations (2652 kg $ha^{-1}$). The yield differences among the irrigation levels were highly significant. These results are supported by Boquet *et al.* (1986), Hutchinson *et al.* (1986), Malik *et al.* (1992) and Khan *et al.* (1993, 1994).

Regarding nitrogen levels, the maximum yield of 3795 kg $ha^{-1}$ of seed cotton was recorded by 168 kg N $ha^{-1}$, which was significantly higher than all other levels. Further 112 kg N $ha^{-1}$ produced 3360 kg $ha^{-1}$ of seed cotton followed by 56 kg N $ha^{-1}$ (2547 kg $ha^{-1}$) against 2020 kg of 0 kg N $ha^{-1}$. The yield differences among the nitrogen levels were highly significant. Similar results have been reported by Bharadwaj *et al.* (1986) and Sawan (1986), Khan *et al.* (1993, 1994). The interaction between years x irrigation, irrigations x nitrogen and years x irrigation x nitrogen were non-significant.

The increase in seed cotton yield by increasing nitrogen and irrigation may be by virtue of more plant height, increased number of bolls per plant, and improved mass per boll. The data depicts that the cotton variety MNH554 has inherited with high potentials of yield, which can be realized through using optimum doses of nitrogen and irrigation.

**Ginning outturn:** The highest ginning outturn (GOT), 43.7 and 43.5 %, respectively obtained in 1998, 1999 was by 56 kg N $ha^{-1}$ with three irrigations, whereas in 2000 it was 44.0 % produced by 0 kg N $ha^{-1}$ and five irrigations. The differences among the years were non significant. On the average of three years, the maximum GOT of 43.5% was obtained by the combination of 56 kg N $ha^{-1}$ with three irrigations followed by 43.4% from 0 kg N $ha^{-1}$ and five irrigations.

Among the irrigation levels, three irrigations gave the highest GOT (431.%) followed by five irrigations (43.0%). However the differences among the nitrogen and irrigation levels were non-significant. Somewhat contradictory results have been reported by Hutchinson *et al.* (1986) that irrigation and fertilizer did not affect lint percentage. In case of nitrogen levels, 0 kg N $ha^{-1}$ produced the maximum ginning out turn (43.2%), whereas the lowest figure was 42.6% obtained by 168 kg N $ha^{-1}$. The variety showed significant response to the increase doses of nitrogen but in reverse order. A slight reduction in lint percentage resulting from increased doses has also been noticed by other workers, Boquet *et al.,*(1986). However the highest differences between the maximum and minimum GOT values was 0.6%, which becomes quite insignificant when increase in the yield of seed cotton is taken into account. The interaction between nitrogen x irrigation, year x irrigation, year x nitrogen and year x nitrogen x irrigation was non-significant. It can be concluded from the results that improvement in lint percentage by increasing nitrogen and irrigation application was not possible.

**References**

Afzal, M. and M. Ali, 1983. Cotton Plant in Pakistan. II edition, Govt. Printing Press, Lahore, Pakistan, pp: 55-82.

Ali, M., 1972. Area, production and varieties. Cotton in Pakistan, PCCC Karachi, Pakistan, 1-38.

Anonymous, 1999-2000. Annual Progress report of Central Cotton Research Institute Multan, Pakistan 1999-2000: 1-256.

Bauer, P.J., P.G. Hunt and C.R. Camp, 1997. In season evaluation of subsurface drip and nitrogen application method for supplying nitrogen and water to cotton. J. Cotton Sci., 1: 29-37.

Bharadwaj, G.S., M.L. Sherma, U.S. Chauhan, 1986. Response of cotton varieties to nitrogen application and irrigated conditions in Chambal Command. Madras Agri. J., 73: 489-492.

Boquet, D.J., A.B. Coco and D.E. Summers, 1986. Effect of irrigation and nitrogen rates on cotton grown on sharkey clay. Annual Progress report, Lousian State University, pp: 27-30.

Bordovsky, J.P. and W.M. Lyle, 1996. Protocol for Planned soil water depletion of irrigated cotton. In Evapotranspiration and irrigation scheduling. Proceeding of the international conference, San Antonio, Texas, U.S.A. (Nov. 3-6).

Chary, J.P. and H.R. Leffler, 1984. Seed in Kohel R.J. Col. C.F. Lewis (ends) Cotton U.S.A Modison, Wiscoinsin, pp: 511-569.

Dhonde P.W., 1985. Response of Cotton (*Gossypium hirsutum* L.) to different fertilizer levels. Mohatma Phule Agri. Uni. Maharashtra, India, Current Res. Reporter., 1: 179-181.

Donald, F. Wanjura, Janies R. Mahan and Dan R. Upchurb, 1996. Irrigation starting time effects on cotton under high -frequency irrigation. Agron. J., 88: 561-566.

Gomez K.A. and A.A. Gomez, 1984, Statistical producer for Agricultural Research (2nd Ed.) Johnwilly and Sons. New York.

Howard, D.D. and P.E. Hoskinson, 1986. Nitrogen fertilizer on cotton, rate and time of application on a lowering silt loam soil. Tennessee Farm and Home Science No.138: 13-16.

Hutchinson, R.L., T.R. Sharp, R. Slaughter and C.W. Kennedy, 1986. Effect of different irrigation schedules on reproduction and vegetative growth of cotton on the Macon ridge. Annual Progress Report St. Joseph, Lousiana Stat-Uni. Northeast Res. Sta., 130-131.

Khan, M.D., M. Hassan, M.A. Khan and M. Ibrahim, 1993. Optimum dose and time of application ofN on cotton variety S-12-Yield and Yield components. Pak. Cotton, 37: 91-96.

Khan, M.D., M. Hassan, M. Ahmed and M. Ibrahim, 1994. Effect of various fertilizer cum irrigation doses on Economic Characters of variety MNH-93 under Multan conditions. Pak. J. Sci., Res., 46: 73-78.

Khan, M.D., M. Hassan, M.A. Khan and M. Ibrahim, 1994. Irrigation and N-use efficiency of Cotton variety MNH129 under Multan conditions. Pak. J. Sci., Res., 46: 1-10.

Malik, M.N. A. and F.I. Choudhry, 1992. Cotton growth and seed cotton yield in relation to plant water deficit. A final research report under USAID/ ISMAR- CGP Research Project III. Pakistan Council of Research in Water Resources, Islamabad, Pakistan. pp: 1-73.

Sawan, Z.M., 1986. Effect of nitrogen, phosphorus fertilizer and growth regulators on cotton yield and fibre properties. CRL, Giza, Jr. Agron., 156: 237-245.

Sawan, Z.M., M.S. Maddah El Din and B. Gregg, 1989. Influence of nitrogen, Phosphorus and growth regulators on seed yield and viability and seedling vigor of Egyptian Cotton. Seed Sci. Technol., 17: 507-519.