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Recovery of Nitrogen Fertilizer and Growth of Cotton as Affected by Various Levels of Flooding

A. W. Soomro, A. R. Soomro and G. H. Mallah
Central Cotton Research Institute, Sakrand, Pakistan

bstract

glasshouse experiment was carried out to evaluate the effect of temporary water logging on the growth and development f cotton and the recovery of nitrogen applied as urea fertilizer, with 3 water treatments i.e. control (W1), moderate flooding V2), and severe flooding (W3). The studies concluded that flooding greatly reduced the growth characteristics of the otton plant such as height, number of leaves, fruiting points and plant dry matter. Recovery of nitrogen applied as urea as significantly decreased with the increase in severity of flooding. Nitrogen losses during temporary flooding appears ainly to higher loss of nitrogen by denitrification, although other mechanisms may be significant. The wider implications the results in terms of field practice with irrigated cotton are discussed.

troduction

r well-developed growth of cotton crop, fruiting and yield adequate supply of nitrogen is essential (Boquet *et al.*, 94; Chaudhry and Sarwar, 1999). Nitrogen is required the plants from the beginning of their growth and an nple supply near and at the flowering stage. The portance of nitrogen in irrigated agriculture has been peatedly stressed. There is a great possibility of increasing tton yields by over-coming the problems concerning pply of nitrogen in flooded soils (Hagin and Tucker, 82).

as been found that too much irrigation water could ate problems associated with excessively wet ditions. Excess water may affect cotton growth through umber of different mechanisms. These include reduction eration, nitrogen loss through denitrification as well as ching, and certain diseases like boll rot in cotton. Effect plant growth may include depression of dry matter yield, nt height, leaf area, fruiting points, seedcotton and lint d (Hodgson, 1982).

ogen fertilizer is normally applied to ensure an adequate ply to the plant, particularly when the crop is grown er irrigation. However, the recovery of applied nitrogen he crops is very low (Soomro and Waring, 1987; Tahir Salim, 1992). The applied nitrogen may be lost from soil plant system through runoff, denitrification, ning, and volatilization (Miller and Wolf, 1987). Nitrate ces are much more readily lost from the soil profile ugh leaching and denitrification resulting in yield ctions (Wayne, 1986). Because of the high cost of genous fertilizers, it is important to minimize nitrogen s and hence improve the efficiency of nitrogen fertilizer e by the crop.

terials and Methods

experiment was conducted during the year 1997 at al Cotton Research Institute, Sakrand. The soil was minimally, passed through a 1-cm sieve and ughly mixed. The experimental design was a split plot with four replications in the following treatment combinations: two urea rates, 100 (F1) and 200-(F2) kg N ha^{-1}; three water regimes, control (W1), moderate flooding (W2) and severe flooding (W3). The essential nutrient elements like P, K, S, B, Zn and Cu were applied at the rate of 100, 180, 25, 1, 2, and 2-kg ha^{-1} respectively. All basal nutrients mentioned as above and urea (50 and 100 kg N ha^{-1} for F1 and F2 respectively) were added in solution form at the time of planting. The remaining doze of urea i.e. 50 kg N ha^{-1} for F1 and 100 kg N ha^{-1} for F2 was applied at the time of appearance of the first true leaf. The plants of variety CRIS-9 were thinned to one per pot at this stage. Plants were watered to field capacity whenever the soil dropped to 50 per cent of the available water. During flood periods, pots of the flooding treatment were watered to give a 1-cm layer of water above the soil for one day for moderate flooding and two days for severe flooding. After flooding the excess water was allowed to dry naturally and watering resumed when the pots dried to 50 per cent available water. Two floodings were applied, the first at 15 and the second at 45 days after planting.

Cotton plants were harvested after 55 days, roots and tops were dried at 80 °C. Total nitrogen in the plant material was determined using kjeldahl method. Observations on plant height, leaves per plant, fruiting points per plant and plant dry matter (tops & roots) were recorded as plant growth parameters. Apparent nitrogen recovery was determined by the following formula:

$$\text{ANR \%} = \frac{\text{(N uptake by F2 treated plant) - (N uptake by F1 treated plant)}}{\text{(N applied in F2 treated pot) - (N applied in F1 treated pot)}} \times 100$$

Results

The soil used under this experiment was clay loam in texture and alkaline in nature, deficient in nitrogen, organic matter and boron (Table-1). Vegetative growth as

expressed by plant height was strongly affected by flooding treatments. Maximum growth occurred in the control (W1). Plant height was decreased with moderate flooding and further decreased by severe flooding (Table-2). Leaves and fruiting points per plant showed similar trend with the application of moderate as well as severe flooding. The application of a higher rate of nitrogen significantly increased production of all the growth parameters such as plant height, leaves per plant and fruiting points. Harvest data showed that water and fertilizer treatments have significant effect on dry matter production (Table 3). The high nitrogen fertilizer rate (F2) gave much higher dry weight than the low rate (F1). Flooding significantly reduced dry matter production. Thus with the control (W1) maximum dry matter was obtained, and it was reduced with the increase in severity of flooding. Similar trend was observed in case of nitrogen uptake by cotton plant. The percentage of nitrogen at harvest (Table 3) was much greater in the treatments with the high rate of fertilizer nitrogen. Flooding increased the nitrogen percentage with little difference between the two flooding treatments.
Nitrogen uptake at harvest (Table 3) was very much lower at the low fertilizer rate (F1). The flooding treatments caused a significant reduction in uptake, and it was decreased with the increase in severity of flooding.

Table 1: Physiochemical properties of the soil used in pots

Soil property	Value
Sand (%)	35.00
Silt (%)	29.00
Clay (%)	36.00
Moisture at field capacity (%)	38.20
pH	8.40
Ec (1:1)	1.32
Organic Matter (%)	0.84
Total nitrogen (%)	0.03
Nitrate Nitrogen (ppm)	1.34
P (ppm)	4.50
K (ppm)	328.00
Mn (ppm)	7.10
B (ppm)	0.53
Zn (ppm)	1.71
Fe (ppm)	9.20
Cu (ppm)	6.36

Table 2: Average plant height, leaves and fruiting points per plant as affected by various flooding and fertilizer treatments.

Treatment	Plant height (cm)	Leaves per plant	Fruiting points per plant
W1	85.8a	48.4a	24.9a
W2	79.9b	45.8b	22.5b
W3	72.9c	42.1c	20.9c
F1	76.9a	39.8a	21.1a
F2	82.1b	51.0b	24.3b

Table 3: Effect of flooding treatments and fertilizer rate on plant dry weight, nitrogen content and nitrogen uptake at harvest

Treatment	dry weight (g)	Nitrogen content (%)	Nitrogen uptake (g per plant)
W1	71.2 a	1.64 a	1.17 b
W2	58.9 b	1.87 b	1.10 bc
W3	47.9 c	1.83 b	0.88 bc
F1	51.8 a	1.63 a	0.84 c
F2	66.9 b	1.93 c	1.29 a

Means followed by similar letter are not significantly different from each other according to DMR Test

The recovery of applied nitrogen fertilizer by the whole cotton plant was strongly affected by flooding treatments (Table 4). Maximum recovery was observed in the control (W1) treatment followed by moderate (W2) and then severe flooding (W3).

Table 4: Effect of flooding treatments on Apparent Nitrogen Recovery (ANR) by the whole cotton plant

Flooding Treatment	Apparent nitrogen recovery (%)
Control (W1)	82
Moderate flooding (W2)	77
Severe flooding (W3)	66

Discussion

The decrease in above growth characteristics of the cotto plant was severe, and may be attributed to the advers effects of depletion of oxygen during the flood period, an the low nitrogen supply and uptake due to anaerob condition of soil. Many researchers have reported simil effects of flooding on plant growth and development. has been concluded that cotton growth is reduced by po aeration (Meek *et al.*, 1980), and results in plants wi reduced height, dry matter and fruiting parts (Hodgso 1982). Under temporary waterlogged conditions, uptake of nitrogen by roots is inhibited owing to depleti of oxygen (Drew and Sisworo, 1977).
The increase in dry matter production, nitrogen uptake various growth characteristics with the high rate of fertilizer application are to be expected in a situatio nitrogen shortage, and are consistent with the finding other researchers (Tomar *et al.*, 1989; Rashiduddin *et* 1994).
The increase in nitrogen percentage of the cotton flooding suggests that, although a reduction in nitr supply almost certainly occurred as a result of floodi was not sufficient to cause additional nitrogen stress that the physiological effects of reduction were significant in reducing plant dry weight. The subst reduction in apparent nitrogen recovery from the flo treatments, especially when severely flooded was pr due to gaseous loss of nitrogen. Biological immobili

of the urea fertilizer is unlikely to have been a factor, since t would have been more pronounced in the non-flooded treatment (Patrick, 1982). Ammonia volatilization may have contributed to gaseous loss, but denitrification is probably the major reason for the reduction in apparent nitrogen recovery from the flooding treatments, since the basic requirement of an anoxic condition (Smith and Tiedje, 1979; Hearn, 1994) was met by the flooding treatments and nitrate substrate.

The results suggest that heavy irrigation is dangerous for crop development as well as for nitrogen losses. Thus care must be taken during irrigation, and light irrigations should always be preferred. Besides, nitrogen fertilizer may be applied in two or three splits to minimize the nitrogen fertilizer losses.

References

Boquet, D. J., E. B. Moser and G. A. Breitenheck, 1994. Boll weight and within plant yield distribution in field grown cotton given different levels of nitrogen. Agron. J., 86: 20-26.

Chaudhry, A. U. and M. Sarwar, 1999. Optimization ofnitrogen fertilization in cotton. Pak. J. Bio. Sci., 2: 242-243.

Drew, M. C. and E. J. Sisworo, 1977. Early effects of flooding on nitrogen deficiency and leaf chlorosis in barley. New Phytol., 79: 567-71.

Hagin, J. and B. Tuker, 1982. Fertilization of dryland and irrigated soils. Advanced Series in Agric. Science. Vol., 12 pp: 22-165. (Springer Verlag: Berlin, Heidelberg)

Hearn, A. B., 1994. The principles of cotton water relations and their application in management. Proceedings of the world cotton research conference 1, pp: 66-92.

Hodgson, A. S., 1982. The effects of duration, timing and chemical amelioration of short-term waterlogging during furrow irrigation of cotton in a cracking grey clay. Aust. J. Agric. Res., 33: 1019-1028.

Meek, B. D., E. C. Owen-Bartlett, L. H. Stolzy and C. K. Labunuskas, 1980. Cotton yields and nutrient uptake in relation to water table depth. Soil Sci. Am. J., 44: 301-305.

Miller, R. W. and Wolf, 1987. Nitrogen inputs and outputs. A valley basis study in 'Nitrogen in the environment' (Eds. R. N. Nolad and J. G. Macdonald) Vol., 1: Academic Press N.Y. pp:163-172.

Patrick, W. H., 1982. Nitrogen transformations in submerged soils. In 'Nitrogen in Agricultural Soils'. (Ed. F. J. Stevenson Am. Soc. Agron. Madison) Agronomy, 22: 449-465.

Rashiduddin, A. W. Soomro and A. S. Arain, 1994. Evaluation of different sources and rates of nitrogenous fertilizers on cotton yield and its components. The Pak. Cottons, 38: 81-92.

Smith, M. S. and J. M. Tiedje, 1979. The effect of roots on soil denitrifiction. Soil Sci. Soc. Am. J., 43: 951-995.

Soomro, A. W. and S. A. Waring, 1987. Effect of temporary flooding on cotton growth and nitrogen nutrition in soils with different organic matter levels. Aust. J. Agric. Res., 38: 91-99.

Tahir, M. and M. Salim, 1992. Relative efficacy of different nitrogen sources and levels for wheat crop under rainfed conditions. Pak. J Agric. Res., 13: 227-231.

Tomar, S. P. S., S. S. Tomar and T. Shrivastava, 1989. Effect of soil and foliar application of nitrogen and phosphorus on yield of seedcotton (*Gossypium hirsutum* L.). Ind. J. Agric. Sci., 59: 506-508.

Wayne, E. M., 1986. Evaluation of nitrogen sources and timing of applications for cotton production. Beltwide Cotton Prod. Research Conference Proceedings 1986, pp: 394-396.