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# Studies on crop yield responses to deficit irrigation and levels of nitrigen in wheat

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**Abstract**

*An experiment was conducted on wheat with water and nitrogen variables in three replications during Rabi 2006-07 to 2008-09 at Agricultural Research Station, Sriganganagar. Nine water regimes ranging from maximum soil water potential in regime 1 to bare minimum in regime 9 were taken within sprinkler pattern using line source sprinkler plot design. Four equal spaced nitrogen levels (60, 90, 120 &150kg N/ha) were arranged at right angles to water variables. The maximum yield of wheat was recorded at 46 to 50 cm water application in the crop fertilized with 150 kg N/ha. At the application of 35 to 45 cm water 120kg N/ha found optimum. Application of 90kg N/ha was sufficient with 30 to 34 cm of irrigation water for wheat crop.*

*Key words:Water regimes, sprinkler, optimum, Nitrogen*

## Introduction

In India, availability of irrigation water is the major limiting factor in improving wheat productivity. Two decades ago, more than 60% of wheat in India was grown under rain fed situation. Now wheat cultivation scenario has changed. At present, more than 60% of wheat area is under irrigated condition, of which about 50% receive only 1 or 2 irrigations. There is need to improve irrigation efficiency through optimization of irrigation water under conditions of limited water availability Due to paucity of irrigation water accompanied with the provision of subsidy on construction of farm reservoir and purchase of sprinkler, the farmers of the region are slowly adopting pressurized system of irrigation.. The timing of the deficit irrigation is a tool for scheduling the use of a limited water supply and in setting priorities among several irrigated crops. On the basis of the relationship between crop yield and water applied, it is possible to optimize the application of available irrigation water. The relationship of crop yield with water and nitrogen use has been a major focus of agricultural research in the arid and semi arid regions of the country. The effect of irrigation and nitrogen application on the crop production is usually quantified using crop production that relates crop yield with the amount of water applied or their efficiency. This procedure can be used in managing water and nitrogen for maximizing the crop yields with inputs applied and subsequent cost-benefit analysis (English and Raja, 1997). Due to the gradual depletion of water resources, the situation is again changing and time may come, when farmers may hardly get water to apply sufficient irrigations to their crop. The present study was under taken to determining the optimum amount of inputs required in producing appreciable and sustainable wheat yields.

## Materials and Methods

An experiment was conducted on wheat with water and nitrogen variables in three replications during Rabi 2006-07 to 2008-09 at Agricultural Research Station, Sriganganagar. Nine water regimes ranging from maximum soil water potential in regime 1 to bare minimum in regime 9 were taken within sprinkler pattern using line source sprinkler plot design. Four equal spaced nitrogen levels (60, 90, 120 &150kg N/ha) were arranged at right angles to water variables. The system was producing a water application pattern uniform along the length of the plot and continuous, but uniformly variable across the line of sprinkler. The soil of experimental site was sandy loam in texture, low in organic carbon (0.19%), having field capacity 16.2%, permanent wilting point 6.3%, medium in available $P_2O_5$ (33 kg/ha), and high in available $K_2O$ (330 kg/ha). The pH (1:2) and EC (1:2) of the soil were 8.1 and 0.2 dS/m, respectively. Wheat variety Raj-1482 was sown during all the years. Pre-sowing irrigation of 100 mm was applied for better land preparation and better establishment of the crop.

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## Results and Discussion

*Water Regimes:*

Increasing application of irrigation water from 310.47 to 493.43 mm increased the grain and straw yield of wheat. After that a slight reduction in yield was observed. The highest grain yield (52.45 q/ha) was recorded with water regime $I_2$ (493.43mm) (Table 1). Plant height, ear length and number of effective tillers were also increased with increasing levels of irrigation up to $I_2$ water regime. Water expense efficiency is generally considered as a conservative term and is expressed as the ratio of economic yield to water supply expressed in term of ET or transpiration on daily or seasonal basis (Sinclair et al 1984). The water expense efficiency was maximum (12.42 kg/ha mm) when minimum water was applied to the crop, while it was minimum (9.24 kg/ha mm) with the application of maximum water to the crop (Table 2). Kibe et al 2003 reported the water use efficiency ranged from 1.22 to 1.42 kg grain / $m^3$ water used. Further, he also reported that higher water use efficiency was observed at one or two irrigation levels compared to other higher irrigation levels.

*Nitrogen Levels*

Application of nitrogen had a progressive response on plant height, ear length and number of

Table 1: Effect of water regimes and N levels on crop yield and yield attributes of wheat (pooled)

| Treatments | Grain yield (q/ha) | | | | Plant height (cm) | Ear length (cm) | No. of effective tillers/m | Straw yield (q/ha) |
|---|---|---|---|---|---|---|---|---|
| | 2006-07 | 2007-08 | 2008-09 | Pooled | | | | |
| Water regimes | | | | | | | | |
| $I_1$ | 48.6 | 45.4 | 43.8 | 45.97 | 96.63 | 9.50 | 102.58 | 70.05 |
| $I_2$ | 53.2 | 55.0 | 48.9 | 52.45 | 96.92 | 9.79 | 104.04 | 71.66 |
| $I_3$ | 51.1 | 47.3 | 44.1 | 47.53 | 97.46 | 9.71 | 97.79 | 67.33 |
| $I_4$ | 48.8 | 44.0 | 42.2 | 45.04 | 96.17 | 9.46 | 96.17 | 67.09 |
| $I_5$ | 48.6 | 44.1 | 41.9 | 44.89 | 96.21 | 9.42 | 95.38 | 68.75 |
| $I_6$ | 47.5 | 43.6 | 41.5 | 44.23 | 94.75 | 9.17 | 96.33 | 67.14 |
| $I_7$ | 45.6 | 42.9 | 40.6 | 43.10 | 94.33 | 9.17 | 94.17 | 65.54 |
| $I_8$ | 39.3 | 42.5 | 39.6 | 40.51 | 93.67 | 8.79 | 92.25 | 62.84 |
| $I_9$ | 39.1 | 39.2 | 37.3 | 38.55 | 92.13 | 8.79 | 92.17 | 57.94 |
| SEm± | 0.98 | 2.27 | 1.51 | 0.97 | 0.52 | 0.16 | 1.08 | 2.10 |
| CD at5% | 2.07 | 4.84 | 3.20 | 2.05 | 1.09 | 0.33 | 2.29 | 4.46 |
| Nitrogen levels | | | | | | | | |
| $N_1$ (60kg/ha) | 43.2 | 41.48 | 38.9 | 41.21 | 92.15 | 9.00 | 92.31 | 59.29 |
| $N_2$ (90kg/ha) | 46.4 | 43.20 | 41.1 | 43.60 | 95.17 | 9.33 | 96.09 | 65.17 |
| $N_3$ 120kg/ha) | 48.6 | 47.00 | 43.3 | 46.33 | 96.81 | 9.70 | 99.31 | 70.04 |
| $N_4$ 150kg/ha) | 49.3 | 48.05 | 45.5 | 47.63 | 97.31 | 9.20 | 99.33 | 71.45 |
| SEm± | 0.65 | 1.51 | 1.01 | 1.47 | 0.79 | 0.22 | 1.84 | 2.39 |
| CD at5% | 1.30 | 3.04 | 2.02 | 2.95 | 1.60 | 0.44 | 3.69 | 4.80 |

Table 2: Effect of different irrigation treatments on water use and water expense efficiency

| Water regimes | Total water applied (mm)* | | | | Water expense efficiency (Kg/ha mm) | | | |
|---|---|---|---|---|---|---|---|---|
| | 2006-07 | 2007-08 | 2008-09 | Average | 2006-07 | 2007-08 | 2008-09 | Average |
| $I_1$ | 527.5 | 476.6 | 487.7 | 497.25 | 9.22 | 9.54 | 8.98 | 9.24 |
| $I_2$ | 506.9 | 518.1 | 455.3 | 493.43 | 10.51 | 10.63 | 10.76 | 10.63 |
| $I_3$ | 483.3 | 507.0 | 445.0 | 478.43 | 10.58 | 9.33 | 9.93 | 9.94 |
| $I_4$ | 453.8 | 488.7 | 448.2 | 463.56 | 10.76 | 9.02 | 9.42 | 9.71 |
| $I_5$ | 418.4 | 469.3 | 429.8 | 439.15 | 11.62 | 9.40 | 9.76 | 10.22 |
| $I_6$ | 344.6 | 437.3 | 427.6 | 403.16 | 13.78 | 9.97 | 9.96 | 10.97 |
| $I_7$ | 280.3 | 410.8 | 420.6 | 370.56 | 16.30 | 10.45 | 9.67 | 11.63 |
| $I_8$ | 224.8 | 389.3 | 415.0 | 343.03 | 17.51 | 10.93 | 9.55 | 11.81 |
| $I_9$ | 182.3 | 340.0 | 409.1 | 310.47 | 21.46 | 11.53 | 9.11 | 12.42 |

*Including rainfall and pre-sowing irrigation

effective tillers/plant. Plant height and number of effective tillers/plant increased significantly with an increase in the application of nitrogen up to 120kg/ha (Table 1).Similarly, increase in the nitrogen application to wheat crop from 60 kg N/ha to 120 kg N/ha, significantly increased the grain and straw yield of wheat. Further, increase in N application (150kg N/ ha) did not increased the grain yield of wheat significantly over 120 kg N/ha. Significantly higher grain yield of wheat (46.33 q/ha) was recorded with the application of 120 kg N/ha over its lower doses. The response of nutrient to the grain yield of wheat was inversely responding to the applied nutrient (Yadav and Verma 1991 also have the same opinion). Maximum nitrogen efficiency (68.68 kg/ha/kg of N) was observed with minimum application of nitrogen ie 60kg N/ha.

*Interaction*

Table 3: Interaction effect of water regimes and N levels on yield of wheat

| N levels/ Water regimes | $N_1$ | $N_2$ | $N_3$ | $N_4$ |
|---|---|---|---|---|
| $I_1$ | 42.35 | 45.68 | 46.98 | 48.89 |
| $I_2$ | 45.99 | 48.21 | 55.12 | 60.49 |
| $I_3$ | 42.96 | 44.88 | 49.63 | 52.65 |
| $I_4$ | 40.80 | 45.04 | 46.42 | 47.90 |
| $I_5$ | 41.23 | 43.27 | 45.80 | 45.26 |
| $I_6$ | 42.59 | 42.47 | 44.20 | 43.65 |
| $I_7$ | 38.15 | 41.72 | 44.99 | 43.56 |
| $I_8$ | 36.35 | 41.00 | 43.46 | 42.22 |
| $I_9$ | 40.56 | 41.19 | 39.38 | 34.07 |
| SEm± | | 4.43 | | |
| CD at5% | | 8.88 | | |

The interaction effect of amount of irrigation water and levels of nitrogen applied was found significant. The highest grain yield (60.49 q/ha) was recorded with $I_2$ level of irrigation with 150 kg N/ha ($N_4$), which was significantly superior over other treatment combination except $I_2$ x $N_3$, and $I_3$ x $N_4$. Chattopadhyay et al 2001 was also observed the similar inter action effect of irrigation water and nitrogen application in wheat crop. The maximum grain yield of wheat was recorded at 46 to 50 cm water application in the crop fertilized with 150 kg N/ha. At the application of 35 to 45 cm water 120kg N/ha found optimum. Application of 90kg N/ha was sufficient with 30 to 34 cm of irrigation water for wheat crop.

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