*Plant Archives* Vol. 16 No. 1, 2016 pp. 395-398 ***ISSN 0972-5210***

# EFFECT OF DIFFERENT LEVELS OF IRRIGATION UNDER INTEGRATED NUTRIENT MANAGEMENT (INM) ON WHEAT (*TRITICUM AESTIVUM* L.) FOR CENTRAL PLAIN AGRO CLIMATIC ZONE OF UTTAR PRADESH, INDIA

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## Abstract

An experiment was carried out on wheat of the Student Instructional Farm, C. S. Azad University of Agriculture and Technology, Kanpur (U.P.), India during *rabi* season, 2010-11. The treatments comprised of 4 irrigation levels *viz*. ( $I_1$- one irrigation at crown root initiation stage (CRI), $I_2$ - two irrigation at CRI + tillering stage, $I_3$- Three irrigation at CRI + tillering + flowering stage, $I_4$- Four irrigation at CRI + tillering + flowering + milking stage as main plot treatments. And three fertilizer levels *viz*., RDF 120:60:60 kg/ha ($F_1$), RDF + Azotobacter ($F_2$) and RDF + Azotobactor + PSB ($F_3$) were tried as sub plot. The experiment was laid out in split plot design. Twelve treatment combinations were replicated three times. The results revealed that the plant height, LAI, dry matter accumulation and number of tillers were highest under ($I_4$) CRI + tillering + flowering and milking stage along with ($F_3$) RDF + Azotobacter + PSB. The level of 4 irrigations produced highest grain yield 49.20 qha$^{-1}$ followed by 3 and 2 irrigations with 44.28 and 38.97 qha$^{-1}$, respectively. Water use was also maximum of 262.6 mm with 4 irrigations against 236,03 mm at 3 irrigations and 204.84 mm at 2 irrigations, but WUE was found highest 33.96 kg/ha- mm at 3 irrigations over 31.72, 31.40 and 29.36 kg/ha -mm at 1, 2 and 4 irrigations, respectively.

***Key words :*** RDF, azotobactor, irrigation, PSB, WUE and wheat.

## Introduction

Wheat is the most important food crop of whole world. Globally, it is grown in 122 countries and occupies an area of 221.12 million ha producing nearly 697.8 million tonnes and productivity 3160 kgha$^{-1}$ of wheat during *rabi* season (USDA, 2012-13). Wheat is the most important winter crop grown in India during *rabi* season (November to April). This golden grain winter cereal is a major contributor to the food security system and provides more than 50 per cent calories to the people, who are mostly dependent on this staple food. India is the major wheat producing country in the world. It ranks second only after China and at present produces more wheat than the United States of America. An average yield of last five years, India grown wheat on 29.64 million ha area with the production of 92.46 million tonnes and productivity of 3120 qha$^{-1}$ grains (USDA, 2012-13). Though, wheat is the second most important staple food after rice in India, it derives more attraction in the food market because of better nutritional values as compared to the rice, which is consumed by the large population. Ready to eat food products with better self life are the key components of retail shops that attract a large number of consumers particularly in urban areas.

Besides fertilizers, irrigation plays an important role in exploiting yield potential of high yielding wheat varieties. Better advantage of optimum dose of fertilizer application is possible only under assured irrigated condition. It has been well established that dwarf wheat produces their potential yield when it is irrigated at all critical stages of plant growth *viz*. crown root initiation, late tillering, late jointing, flowering, milking and dough stage. In most of the wheat growing areas of Uttar Pradesh, sufficient and assured irrigation water is not available for irrigation at all critical stages. It is the main reason for low wheat productivity in the state.

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## Materials and Methods

The experiment was conducted at Students Instructional Farm (SIF) of C.S. Azad University of Agriculture and Technology, Kanpur (U.P.), India during *rabi* season of 2010-11. The experimental farm falls under the Indo-gangetic alluvial tract and irrigated by tube well. Geographically, Kanpur is situated in the central part of Uttar Pradesh and subtropical tract of North India between latitude ranging from $25^0$ 56, 58 North and longitude $79^0$ 31, 34 East and is located on an elevation of about 125.9 meters above mean sea level. The seasonal rainfall of about 816 mm received mostly from second forth night of June or first forth night of July to mid October with a few showers in winter season. The mean weather data such as weekly average temperature, relative humidity (R.H.), wind speed, evaporation rate and total rainfall etc. were recorded during crop season from meteorological observatory located at student Instructional Farm. The sample taken with augor from 0-15 cm depth in field collected randomly. The treatments were considered four irrigation levels ( $I_1$- one irrigation at crown root stage (CRI), $I_2$ - two irrigation at crown root stage + tillering stage, $I_3$ - Three irrigation at CRI + tillering and flowering stage, $I_4$- four irrigations at CRI + tillering + flowering and milking stage as main plot treatments and three fertility sources *viz*., $F_1$- RDF 120:60:60 kg/ha, $F_2$- RDF + Azotobacter, $F_3$- RDF + Azotobacter + PSB as sub plot treatments. Twelve treatment combinations were replicated three times. The soil of experimental site was sandy loam in texture with low organic carbon (0.44%) and nitrogen (176.0 kg/ha) medium in phosphorus (19.0 kg/ha) and potassium (165 kg/ha). The wheat cultivar Gangotri (K9162) was sown at proper moisture on 05 December, 2010. Sowing was done in 20 cm apart and 4-5 cm deep in furrows opened by countrty plough. Certified seed was used @ 100 kg/ ha in all the plots. After sowing of seed planking was done twice to cover the seed with soil properly. Half amounts of nitrogen together with full amount of phosphorus, potash were applied as basal at the time of sowing in the form of urea, DAP, MOP and Azotobacter + PSB respectively. Remaining half dose of nitrogen was top dressed into two split doses at 32 and 56 days after sowing (DAS).

## Results and Discussion

Increase the irrigation levels with increased the yield attributes *viz*., length of ear, number of grains/ear and test weight significantly. The wettest moisture level (four irrigations) performed favourable vegetative growth and development because it received adequate moisture. The plant height, LAI and dry matter accumulation were highest, which contributed to highest yield attributes due to increased photosynthesis activity of leaves, beside, translocation of phostosynthates from source to sink, higher uptake of potassium under wettest condition also lead to better yield attribute (Naseri *et al*., 2010). Irrigation levels significantly affected the grain and straw yield (table 1). Increasing number of irrigations increased grains yield significantly upto 4 irrigations. The highest grain 49.20 $qha^{-1}$ and straw yield 57.86 $qha^{-1}$ was recorded with 4 irrigations. It could be due to higher plant water status as a consequence of stometal conductance, which might have resulted in higher rate of cell division and cell elongation more accumulation of photosynthesis and their higher mobilization from various plants part. The results are in confirmation with the findings of (Singh *et al*., 2012).

Plant height, dry matter accumulation, leaf area index and number of tillers the maximum and minimum of these characters were credited to RDF + Azotobacter + PSB ($F_3$) and RDF 120:60:60 kg/ha ($F_1$), respectively. It might be due to the mineral nitrogen and potassium carbohydrates synthesized in the green part of the plant which metabolized into amino acids and finally into protein the plant to grow faster, adequate supply of nutrients favoured the nutrient uptake and nutrient utilization towards protein which favoured vertical and lateral growth of the plant ultimately increased the area of leaves (Yadav and Verma, 1991). The maximum yield attributes *viz*., length of ear, number of grain/ear and test weight were recorded with RDF + Azotobacter + PSB ($F_3$), which was higher over RDF 120:60:60 kg/ha ($F_1$) and RDF + Azotobacter ($F_2$), respectively. Application at different fertilizers increased the dry matter accumulation accordingly in assimilating organs that in turn brought about increase in yield attributes (Joshi, 1980). The maximum grain and straw yield were obtained with RDF + Azotobacter + PSB ($F_3$), which was significantly higher over RDF 120:60:60 kg/ha ($F_1$) and RDF + Azotobacter ($F_2$), respectively. Application of RDF (120:60:60 kg/ha) with Azotobacter + PSB crop were able to absorb larger quantity of nitrogen, phosphorus and potassium through, their well developed, root system. Secondly the chemical fertilizer not only enhanced the production of photosynthates, but also its translocation from source to sink, resulted in increased number of spikelet's $spike^{-1}$, length of spike and number of seeds which have positive relationship with grain yield. These results are conformity with those of (Singh *et al*., 19978).

Harvest index was significantly affected by irrigation levels. The maximum harvest index (47.65%) was found

**Table 1 :** Yield attributes parameters, grain and straw yield and harvest index of wheat as influenced by irrigation levels and integrated fertility sources.

| Treatment | Yield attributes parameter | | | Grain yield (q/ha) | Straw yield (q/ha) | Harvest index (%) | Total water use (mm) |
|---|---|---|---|---|---|---|---|
| | Length of ear (cm) | Number of grains/ear | Test weight (g) | | | | |
| **Irrigation levels** | | | | | | | |
| Crown root initiation stage | 7.83 | 34.77 | 41.55 | 32.93 | 38.27 | 46.03 | 160.10 |
| Crown root stage +tillering stage | 7.88 | 40.11 | 40.00 | 38.97 | 47.46 | 45.05 | 204.84 |
| (CRI) + tillering +flowering stage | 8.00 | 45.22 | 42.50 | 44.28 | 52.90 | 45.43 | 236.03 |
| (CRI) + tillering+ flowering + milking stage | 8.05 | 46.66 | 42.55 | 49.20 | 57.86 | 47.65 | 262.6 |
| SEd.± | 0.25 | 0.94 | 0.58 | 1.38 | 1.79 | 0.17 | - |
| CD (P=0.05) | 0.61 | 2.30 | 1.42 | 3.38 | 4.38 | 0.41 | - |
| **Integrated fertility sources** | | | | | | | |
| RDF 120:60:60 kg/ha | 7.75 | 34.75 | 40.66 | 36.37 | 45.35 | 44.58 | 216.04 |
| RDF + Azotobacter | 7.87 | 40.41 | 41.33 | 41.36 | 49.73 | 46.52 | 220.82 |
| RDF + Azotobacter + PSB | 8.20 | 46.16 | 42.25 | 46.30 | 52.29 | 47.02 | 225.79 |
| SEd.± | 0.20 | 0.66 | 0.51 | 0.82 | 1.37 | 0.16 | - |
| CD (P=0.05) | 0.44 | 1.41 | 1.08 | 1.75 | 2.80 | 0.32 | - |

**Table 2 :** Plant height, dry matter accumulation, leaf area index and number of tillers of wheat as influenced by irrigation levels and integrated fertility sources.

| Treatment | Plant height at 90 DAS | Dry matter accumulation ($gm^{-1}$ row length) at 90 DAS | Leaf area index at 90 DAS | Number of tillers ($m^{-1}$ row length) at 90 DAS | Water use efficiency (kg/ha-mm) |
|---|---|---|---|---|---|
| **Irrigation levels** | | | | | |
| Crown root initiation stage | 78.11 | 22.30 | 3.12 | 2.66 | 31.72 |
| Crown root stage + tillering stage | 79.55 | 22.24 | 3.86 | 2.44 | 31.40 |
| (CRI) + tillering + flowering stage | 80.11 | 22.10 | 4.00 | 2.66 | 33.96 |
| (CRI)+tillering+ flowering+ milking stage | 80.00 | 22.67 | 4.31 | 3.00 | 29.36 |
| S. Ed. ± | 0.83 | 0.42 | 0.12 | 0.13 | - |
| CD (P = 0.05) | 2.03 | 1.04 | 0.31 | 0.33 | - |
| **Integrated fertility sources** | | | | | |
| RDF 120:60:60 kg/ha | 78.91 | 21.09 | 3.45 | 2.41 | 28.12 |
| RDF + Azotobacter | 79.41 | 22.41 | 3.46 | 2.66 | 31.68 |
| RDF + Azotobacter + PSB | 80.00 | 23.55 | 3.85 | 3.00 | 35.03 |
| S.Ed. ± | 0.88 | 0.27 | 0.23 | 0.27 | - |
| CD (P = 0.05) | 1.86 | 0.58 | 0.48 | 0.57 | - |

under CRI + tillering + flowering + milking stage and minimum (45.05%) was found under crown root stage + tillering stage. This might be due to the fact that adequate moisture supply under the higher irrigation levels increased the grain yield than that of biological yield. The maximum harvest index (47.02%) was recorded with RDF + Azotobacter + PSB, which was 1.46% and 5.87% higher over RDF + Azotobacter and RDF 120:60:60 kg/ha, respectively. Which might be due to RDF released N, P and K in soluble form which resulted plant uptake maximum N, P and K from soil while the Azotobactor fix the atmospheric N in soil and PSB increase vigorous growth of root which results higher absorption of nutrient and water from the soil thus increased the dry matter in plants, resulted maximum harvest index over RDF + Azotobacter and RDF 120:60:60 kg/ha, respectively (Shivani *et al*., 2003).

Water use in wheat increased remarkably with increase in irrigation number and thus maximized at 4 irrigation levels (table 1). It was attributed to availability of more soil moisture at different phases of crop growth which was properly utilized by the crop. Beside more proliferation of plant roots in the upper soil layer under higher moisture regimes in case of increased number of irrigation levels may be help full in extracting more soil moisture (Kiani and Mirlatifi, 2012). Water use was maximum recorded in treatment RDF + Azotobacter +PSB ($F_3$) followed by ($F_2$) and ($F_1$) (table 1). The minimum water use was recorded in treatment RDF 120:60:60 kg/ha ($F_1$). It might be due to higher shoot density better yield attributes and biomass production which required more amount of soil moisture as compared to other treatments respect to water use in wheat (Parihar and Tiwari, 2003). WUE reduced with increased in number of irrigation (table 2). It was recorded lowest in 4 irrigation levels and highest at 3 irrigation levels. It might be attributed to better moisture utilization by wheat crop at lower availability of soil moisture under 4 irrigation levels (Li *et al*., 2011).

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