

Response of Different Moisture Regimes and Nitrogen Sources on Soil Health, Growth and Yield Attributes of Wheat: A Comprehensive Review

Abstract

Wheat (*Triticum aestivum* L.), an ancestor of the Poaceae family, is one of the most important cereal crops in the world. Wheat is the most widely grown and produced major cereal on a global scale. In order to maintain wheat as a significant food crop worldwide, irrigation has been essential. It is also becoming more crucial as a response to climate change. The important factor in raising water productivity and preserving the viable use of water resources in the context of agricultural production in response to enhanced irrigation management. Growth and Yield attributes of wheat increased with increasing level of moisture regime at all growth stages of the crop. Higher nitrogen fertilization levels were linked to better performance of yield component parts. All the growth and yield indicators were dramatically raised by various nitrogen levels.

Keywords: Wheat, Irrigation Scheduling, Water, Organic Manure, Soil Health, Yield,

Introduction

Wheat (*Triticum aestivum* L.) is a dominant cereal crop of north-western zone of India and it is second most common crop of the country. In terms of both production and consumption, it is also one of the main staple crops in many parts of the nation. In India wheat is the second-most significant grain crop and is crucial to the nation's food and nutritional security (Kumar *et al.*, 2023).

Irrigation should aim to restore soil water in the root zone to a level at which crop can fully meet its evapotranspiration requirement (Kumar *et al.*, 2023). In its early phases of growth, wheat need water for root development and germination. Reduced plant populations and therefore lower yields of grains are caused by insufficient soil moisture during the early stages of plant growth. Irrigation should be used before seeding to reduce emergence issues caused by soil crusting and make sure the soil has enough water for germination (Gupta *et al.*, 2016). Water is necessary at every stage of plant development, from seed germination through plant maturation, in order to harvest wheat with the highest possible yield. Grain

yield and irrigation frequency have a favourable relationship (Kumar *et al.*, 2012). Irrigation should aim to restore soil water in the root zone to a level at which crop can fully meet its evapotranspiration requirement. (Kumar *et al.*, 2023). The type of crop, growth stage, length of the growing season, plant population, topography of the soil, temperature, relative humidity, wind speed, and crop management practices like tillage, fertilization, and weeding are all factors that affect a crop's need for water. Three approaches, namely the soil moisture depletion strategy, the climate approach (IW/CPE ratio), and the critical stages, can be used to schedule irrigation in wheat. The climatological method is one of them and is extremely beneficial and well-recognized by scientists and research workers around the world.

To maximize production from various wheat varieties, ideal irrigation facilities are crucial (Kumar *et al.*, 2018). In all of the plant's living tissues, nitrogen is essential. Protein, of which nitrogen is a crucial component, is linked to all key functions in plants. Proteins, enzymes, coenzymes, nucleic acids, phytochromes, and chlorophyll all contain nitrogen as a component. It is significant to the plant's biochemical operations. Consequently, it is one of the nutrients that wheat crops need the most (Kutman *et al.*, 2011). Widespread use of better technologies, with fertilizer management particularly that of nitrogen and organic manure playing a crucial role can enable an increase in wheat output that is more environmentally friendly (Kumar *et al.*, 2023). Vermicompost, crop residues, and organic manures are needed in addition to inorganic fertilizers for increased production and healthy soil. By combining inorganic fertilizers with organic manures, crop wastes, and bio-fertilizers, one can improve soil health and accelerate up nutrient uptake (Pandey *et al.*, 2023).

An optimal level of soil fertility and plant nutrient delivery is maintained by combining organic and inorganic manures, optimizing the benefits from all potential sources of plant nutrients in order to maintain the required productivity (Kumar *et al.*, 2023).

Response of Moisture Regimes and Nitrogen Sources on Soil Health

Moisture Regimes and nitrogen sources effects on soil pH. The dilution of salts and leaching of ions outside the root zone may be the cause of the fall in soil pH that occurs with irrigation application based on the IW/CPE ratio. By creating organic acids during their decomposition, the usage of organic manures, such as poultry manure and FYM, has also been shown to contribute to lowering the pH of the soil to some extent. This may also account for the increased availability and mobility of nutrients, particularly micronutrients. (Kumar *et al.*, 2023). Similar finding was observed by Jat *et al.*, 2011.

Kumar *et al.*, (2023) reported that that a slight improvement in organic carbon was obtained with increasing level of moisture regime up to 1.2 IW/CPE ration. It might be caused by the

right soil moisture levels being maintained along with the decomposition of organic wastes and release of solubilized plant nutrients.

Shaaban (2006) reported that, the organic residues improved bulk density, total porosity, macro and micro pores, soil water retention and soil hydraulic conductivity compared with untreated soil. The mixture of chicken manure + sunflower residue was found more effect than those of chicken manure or sunflower residue alone. Another finding was reported by Agbede *et al.*, (2008) reported that the Poultry Manure significantly reduced soil bulk density and temperature and increase porosity and moisture content. The manure increased significantly soil organic matter, soil and leaf N, P, K, Ca and Mg concentrations.

Response of Moisture Regimes and Nitrogen Sources on Growth of Wheat Crop

Saren *et al.* (2004) reported that four irrigations applied at crown root initiation, tillering, flowering and grain development stages resulted in maximum plant height, dry matter accumulation, leaf area index and crop growth rate of wheat on sandy loam soil. The improvement in growth attributes could be assigned to higher moisture availability for crop. These finding support the observation of Rathore *et al.*, (2006).

Gupta *et al.*, (2016) reported that the growth parameters like plant height, number of shoots m^{-1} and dry matter accumulation (gm^{-1}) were found significantly superior under irrigation at 1.2 IW/CPE over other irrigation treatments except irrigation at 1.0 IW/CPE and five irrigations each at CRI, tillering, late jointing, flowering and milking stage. The higher dry matter at higher fertility level might be due to proper nutrition availability which resulted in increased vegetative growth of plants. Similar results also reported by Laghari *et al.* (2010) and Kale *et al.* (2015).

Pandey *et al.* (2017) reported that the comprised of four irrigation levels (a) I₁; 0.6 IW/CPE ratio (b) I₂; 0.8 IW/CPE ratio (c) I₃; 1.0 IW/CPE ratio and (d) I₄; 1.2 IW/CPE ratio with two varieties namely PBW 343 and PBW 502 and three Sulphur levels (a) Control (b) 20 kg/ha (c) 40 kg/ha. The growth attributes plant height, no of shoot m^2 and leaf area index was significantly superior 1.2 IW/CPE ratio with PBW 502 variety at all growth stages.

Singh *et al* (2017) reported that the irrigation levels significantly affected grain and straw yields as well as most of the growth and their attributes of wheat. Four irrigations recorded highest plant height, number of tillers, dry matter accumulation at harvest stage and leaf area index) at 90 DAS as well as higher grain and straw yield over two and one irrigation. Increase in plant height at higher level of irrigation could be possible due to maintenance of constant water supply to the plants, which maintained various metabolic processes. The Similar result was find by Rahman *et al.*, (2006) and Brahma *et al.*, (2007).

Atikullah et al. (2014) evaluate four different irrigation levels viz. I₀: No irrigation i.e. control, I₁: Irrigation at 20 days after sowing (DAS) at crown root initiation stage; I₂: Irrigation at 55 DAS at flowering stage) and I₃: Irrigation at 75 DAS at grain filling stage. Results revealed that maximum dry matter content, crop growth rate (CGR), relative growth rate (RGR) were found from I₁ which was statistically identical with I₂ whereas minimum from I₀. Plant height, number of tiller, number of spike, number of spikelets, spike length, filled grains, total grains, grains weight, grain yield, straw, biological and harvest index were correspondingly showed higher results as of growth characters.

Shah et al., (2006) the results indicated that maximum biological yield, straw and grain yields of wheat were obtained in treatment receiving N from urea and FYM in 75:25 ratios. The next higher yield was obtained in treatment receiving N from the two sources in 50:50 ratios.

Channabasanagowda et al., (2007) reported that effect of different organic manures on growth, seed yield and quality of wheat. Application of vermicompost @ 3.8 t per ha + poultry manure @ 2.45 t per ha recorded significantly higher plant height, number of leaves, higher number of tillers at 90 DAS and it also recorded higher number of ear heads per meter square seed weight and seed yield, and protein content compared to other treatments. RDF also accounted at par yield and yield parameters with that of former treatment.

Rehman et al., (2008) reported that inorganic fertilizers application (NPK) in combination with organic fertilizers in the form of farmyard manure (FYM) can improve wheat yield components and biomass under rain fed condition. Different levels of NPK and FYM alone or in combination had significant effect on spikes m⁻², grains spike⁻¹, biological yield and thousand grain weight. Maximum spikes m⁻² were recorded at 80-60-30 kg NPK ha⁻¹. Farmyard manure at 45 t ha⁻¹ produce the maximum spikes m⁻², grains spike⁻¹, thousand grain weight and biological yield.

Meena et al., (2013) reported that the growth parameters like plant height, number of tillers, dry matter production and number of productive tillers with application of 100% NPK + 300 kg well grow grain/ha and at par with application of 100% NPK + 300 kg well grow soil/ha, 100% NPK + 200 kg well grow grain/ha. Treatment receiving 100% NPK + 300 kg well grow grain/ha resulted maximum effective tillers, grain yield.

Kumar et al (2017) studies that the effect of FYM and Urea Combination on growth, seed yield and quality of wheat. Application of 75% of recommended dose of N through inorganic source + 25% of recommended dose of N through organic source (FYM) ha⁻¹ recorded significantly higher plant height, Leaf area index at 90 DAS and higher number of shoot. At harvest, dry matter accumulation at harvest.

Ullah et al (2018) reported that the growth and yield parameters like number of tillers, plant height, spikelets per spike, seeds per spike, biological yield, 1000 grain weight, grain yield and harvest index. Different levels of nitrogen significantly increased all the growth and yield parameters. Maximum number of tillers, highest plant height and biological yield was recorded from the treatment where nitrogen was applied @ 203 Kg ha⁻¹ while 1000 grain yield, seeds per spike and grain yield was achieved highest from where nitrogen applied @ 145 Kg ha⁻¹.

Response of Moisture Regimes and Nitrogen Sources on Yield Attributes of Wheat Crop

Prashar and Thaman, (2005) reported that irrigation at 50 mm CPE recorded the highest grain yields respectively, followed by irrigation at 40 mm CPE. Water use efficiency decreased with increasing quantity of irrigation water.

Brar et al., (2012) reported that maximum wheat grain yield was obtained when irrigation applied at 1.25 IW: CPE, which was statistically at par with 1.0 IW: CPE. This is might be owing to cumulative effect of number of seed/pod due to improvement of soil moisture and mineral nutrient availability. **Dhindwalet al., (2006)** and **Tripathi and Singh (2007)** reported similar findings.

Ahmad et al (2014) reported that Irrigation schedules (I₇) at crown root initiation + tillering + jointing + flowering + milky + dough stages recorded maximum effective tillers at harvest total dry matter production, leaf area, leaf area index, the mean ear length, number of grains per ear, 1000 grain weight.

Deo et al. (2017) comprised the four levels of irrigation schedule Viz., I₁ (critical stages), I₂ (0.6 IW: CPE ratio), I₃ (0.8 IW: CPE ratio), and I₄ (1:0 IW: CPE ratio). growth attributes such as plant height (cm), number of shoots m⁻² and Leaf area index (LAI) were found significantly higher under I₁ (critical stages) treatment during both year 2014-15 and 2015-16. The total number of effective tillers m⁻², length of spike (cm), harvest index (%) and test weight (gm.) were found higher under I₁ (critical stages) and I₄ (1.0 IW: CPE ratio) treatment during both years. The highest grain yield and straw yield recorded under I₁ (critical stages) treatment during the both years.

Verma et al. (2018) reported that irrigation applied at 0.9 IW/CPE ratio (I₂) recorded the maximum values of growth indices (matter accumulation per metre row length, leaf area index, leaf area duration, crop growth rate, relative growth rate and net assimilation rate) and yield (grain, straw, biological and HI) proved significantly superior over I₁, I₄ and I₃ except treatment I₅.

Pal et al., (2020) reported that the growth attributes *viz.*, number of shoots, plant height, dry matter accumulation and yield attributing characters *viz.*, number of grains spike⁻¹, number of spike m⁻², length of spike, test weight, grain and straw yield by crop was significantly was 1.0 IW/CPE ratio (I₄) moisture regime which was at par with 1.2 IW/CPE ratio (I₅) moisture regime and significantly higher over at the CRI stage (I₁), 0.6 IW/CPE ratio (I₂), 0.8 IW/CPE ratio (I₃).

Ibrahim et al., (2008) observed that the amounts of various organic manures to supplement the inorganic fertilizers must be optimized to increase crop yield. Changes in growth and yield parameters of wheat relative to inorganically fertilized controls were measured. Organic amendments had positive but variable effects. The organic manures application increased the wheat yield by 11.13 % to 13.53 % g plot⁻¹, relative to the control. The wheat plant height, number of tillers, spike length, straw yield, grain yield and 1000- grain weight all were statistically different from that of control.

Shah et al., (2010) reported that the integrated use in different proportion increased the plant height, spike length, grain per spike and 1000-grain weight. Maximum grain yield of 3.5 tha⁻¹ was obtained from treatments where 25% N was applied from FYM 25% N from poultry manure or city waste and 50% from mineral source and in treatment where 25% N was applied from FYM, 25% from city waste and 50% from mineral fertilizer.

Ali et al (2011) studies the effects of different levels of nitrogen on growth and yield of wheat crop at four different nitrogen rates i.e. 0, 80, 130 and 180 kg ha⁻¹. Date of sowing was during the last week with seed rate of 100 kg ha⁻¹. The results showed that number of tillers per unit⁻¹, plant height, spike's length, number of grain spike⁻¹, 1000-grain weight and grain yield were significantly increased by increasing the nitrogen levels over control.

Singh et al(2011) assess the effect various types of organic and inorganic fertilizers on growth, yield attributes and NPK acquisition. The results revealed that growth attributes *viz.* number of tillers Hill-I and plant height significantly increased due to presence of nitrification inhibitors in mmco fertilizer, they slowly supplied nitrogen to plant and decreased the loses of nutrients resulting more nitrogen available to plant. Combined application of organic manures and inorganic fertilizers increased the dry matter accumulation, number of grains Spike-I, gram yield, straw yield and NPK uptake by wheat crop compare to treatment T₂ where full dose of NPK applied through urea, single superphosphate and muriate of potash.

Yousaf et al (2014) reported thatthe effects of the different nitrogen fertilization levels and irrigation timing on the agronomic performance of wheat. The different nitrogen doses

applied to the soil were 0, 80, 100, 120 and 150 kg ha⁻¹ while, irrigation timings were at 15, 20, 25 and 30 days after germination. Nitrogen applied at 120 and 150 kg N ha⁻¹ while kept the irrigation timing of 25 days after germination achieved the highest plant height, more tillers number, maximum number of fertile tillers and highest yield respectively, as compared to control and other treatments.

Shahid *et al.*, (2015) reported that application of poultry manure (layer or broiler) increased yield components and grain yield significantly. Grain yield, grain crude protein contents, number of fertile tillers, spike length, flag leaf area, fresh weight, dry weight, plant height and number of grains increased with each increasing rate of applied nitrogen.

Sheoran *et al* (2016) reported that the application of organic manures in combination with N and P fertilizers significantly increased all yield attributes, i.e. plant height, number of tillers/m row length, spike length, number of grains/spikes. Higher grain yield of wheat was observed when recommended dose of N and half of P was applied in conjunction with FYM, poultry manure and press mud, respectively.

Deo *et al.*, (2017) found the moisture regimes had significant effect on the straw yield of wheat. The highest straw yield was recorded in I₁ (critical stages) treatment and lowest under I₂ treatment. Treatment I₁ and I₄ treatment were found to be at par with each other. Similar finding was observed by the (Brahma *et al.* 2006).

Yousaf *et al.*, (2014) reported that the grain yield was significantly affected by nitrogen levels and irrigation timings. Maximum grain yield was produced in those treatments where nitrogen levels were 120 and 150 kg/ha and the crop was irrigated after 20 and 25 days of germination.

Minimum grain yield was found in those plots where nitrogen levels were zero. Higher grain yield was determined in the case where nitrogen levels were 120 and 150 kg/ha and crop was irrigated after 20 and 25 days of germination. This could be because the nitrogen supply, which began during the early stages of vegetative growth and continued through flowering, synchronized with the crop's need for nitrogen and resulted to the largest density of fertile tillers per square metre and the maximum grain spike filling. Similar finding was observed by the Gill *et al.*, (1999) and Maqsood *et al.*, (2002).

Conclusion

Results from this study that the suitable irrigation schedule for wheat crop produced significantly the highest Plant height, number of shoot, leaf area index, effective teller, grain

yield, straw yield and harvest index. The Nitrogen sources was found suitable for growth and yield of wheat crop.

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