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.), a ancestor of the Poaceae family, is one of the most important cereal crops in the world. On a global scale, wheat is the main cereal that is cultivated and produced most widely. Irrigation has been essential to keep wheat a key food crop around the world. In response to climate change, it is also becoming more important. In response to better irrigation management, a key aspect in increasing water productivity and maintaining the viability of water resource use in agricultural production. At all growth stages of the crop, the wheat crop's growth and yield characteristics improved with rising levels of moisture regime. The performance of the yield component parts has been linked to higher nitrogen fertilization levels.

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

Introduction

Wheat (*Triticum aestivum* L.) is a main cereal crop 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 it is the second-most significant grain crop and is crucial to the nation's food and nutritional security (Kumar *et al.*, 2023).

The goal of irrigation should be to replenish the soil water content in the root zone to a point where the crop can completely satiate its evapotranspiration needs (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 throughout the initial phases 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). To produce wheat with the maximum yield attainable, water is required at all stages of plant development, from seed germination to plant maturation. A positive association is present between irrigation frequency and grain yield (Kumar *et al*., 2012). 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). Nitrogen is crucial for all of the plant's living tissues. All of a plant's essential processes are associated with protein, of which nitrogen is a critical component. Nitrogen is a constituent of proteins, enzymes, coenzymes, nucleic acids, phytochromes and chlorophyll. It is significant to the plant's biochemical operations. Consequently, it is unique 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

Shaaban (2006) Compared to untreated soil, the organic residue improved bulk density, total porosity, macro and micro pores, soil water retention, and soil hydraulic conductivity. It was discovered that the combination of poultry manure and sunflower residue had a greater impact than either poultry manure or sunflower residue alone. Another finding was reported by Agbede *et al.,* (2008) reported that Poultry manure considerably increased soil porosity and moisture content while reducing soil bulk density and temperature. The contents of soil organic matter, soil and leaf N, P, K, Ca and Mg were all significantly elevated by the manure. Similar finding observed by Akanni *et al*., 2005).

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 results were noted 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 breakdown of organic litters and discharge of solubilized plant nutrients.

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

Saren *et al.,* (2004) reported that wheat grown on sandy loam soil produced the highest plant height, dry matter accumulation, leaf area index, and crop growth rate after four irrigations provided at the crown root initiation, tillering, blooming, and grain development stages. An increase in crop moisture availability may be responsible for the improvement in growth characteristics. These finding support the observation of Rathore *et al*., (2006).

Shah *et al.,* (2006) showed that the 75:25 ratio of N from urea and FYM produced the highest biological yield, straw yield, and grain yield of wheat. The subsequent treatment that received N from the two sources in a 50:50 ratio produced the highest yield.

Channabasanagowda *et al.,* (2007) reported the impact of several organic manures on wheat quality, seed output, and growth. When compared to other treatments, the application of vermicompost at 3.8 t per ha and poultry manure at 2.45 t per ha significantly increased plant height, the number of leaves, the number of tillers at 90 DAS, the number of ear heads per metre square, seed weight and seed yield, and protein content.

Rehman *et al.,* (2008) said that, it can boost wheat yield components and biomass under rain-fed conditions to apply inorganic fertilizers (NPK) along with organic fertilizers in the form of farmyard manure (FYM). Spikes m-^{2}, grains spike-^{1}, biological yield, and thousand grain weight were significantly affected by various levels of NPK and FYM either separately or in combination. At 80-60-30 kg NPK ha-^{1}, the highest spikes m-^{2} were noted. The highest spikes m-2, grains spike-^{1}, thousand grain weight, and biological yield are produced by farmyard manure at 45 t ha-^{1}.

Atikullah *et al.,* (2014) reported that the maximum dry matter content, crop growth rate, relative growth rate were found from I_1 (Irrigation at 20 days after sowing at crown root initiation stage) which was statistically identical with I_2 (Irrigation at 55 DAS at flowering stage) whereas minimum from I_0 (No irrigation). 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.

Gupta *et al*., (2016) reported that irrigation at 1.2 IW/CPE was significantly superior to other irrigation treatments in terms of plant height, number of shoots m^1, and dry matter accumulation (gm^1), with the exception of irrigation at 1.0 IW/CPE and five irrigations at the CRI, tillering, late jointing, flowering, and milking stages. The availability of sufficient nutrients may have contributed to the enhanced vegetative development of plants, which in turn led to the higher dry matter at higher fertility levels. Both Laghari *et al*., (2010) and Kale *et al*., (2015) reported results that were similar.

Pandey *et al.*, **(2017)** reported that the consisted of three sulphur levels (a) Control (b) 20 kg/ha (c) 40 kg/ha) and four irrigation levels (a) I_1 0.6 IW/CPE ratio (b) I_2 0.8 IW/CPE ratio (c) I_3 1.0 IW/CPE ratio and (d) I_4 1.2 IW/CPE ratio). At all growth phases, the PBW 502 variety greatly outperformed other cultivars in terms of plant height, number of shoots per square metre and leaf area index (1.2 IW/CPE ratio).

Singh *et al.*, (2017) reported that the irrigation levels has significant effects on wheat growth and characteristics, as well as grain and straw yields. In a comparison with two and one irrigation, four irrigations recorded the highest plant height, tiller count, dry matter accumulation at harvest stage, and leaf area index at 90 DAS, as well as greater grain and straw output. The ability of plants to grow taller at higher irrigation levels may result from the maintenance of numerous metabolic processes by the plants' steady water supply. The Similar result was find by Rahman *et al*., (2006) and Brahma *et al.*, (2007).

Kumar *et al.*, (2017) studies on the effect of FYM and urea combination on wheat quality, seed production, and growth. Plant height, Leaf area index at 90 DAS, and the number of shoots increased significantly after applying 75% of the prescribed dose of N through inorganic sources and 25% of the recommended dose of N through organic sources (FYM) ha^1.

Ullah et *al.*, (2018) reported on the number of tillers, plant height, spikelets per spike, seeds per spike, biological yield, 1000 grain weight, grain yield, and harvest index as well as other growth and yield data. All growth and yield indicators were dramatically raised by various nitrogen levels. The treatment with nitrogen applied at 203 kg $ha\text{-}^1$ produced the most tillers, the tallest plants, and the best biological yield; however, the treatment with nitrogen applied at 145 kg $ha\text{-}^1$ produced the highest grain yield, seeds per spike, and 1000 grain yield.

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

Prashar and Thaman, (2005) reported that the best grain yields were achieved with irrigation at 50 mm CPE, followed by irrigation at 40 mm CPE. As irrigation water usage increased, it became less efficient.

Ibrahim *et al.,* (2008) observed that in order to achieve maximum crop output, the quantities of different organic manures added with the inorganic fertilizers must be optimized. The determined changes in wheat's growth and yield metrics compared to controls that received only inorganic fertilizer. The impacts of organic amendments were usually favourable. In comparison to the control, the application of organic manures enhanced the wheat yield. In comparison to the control, the wheat plant's height, tiller count, spike length, straw yield, grain yield, and weight per 1000 grains were all significantly different. Similar results are in agreement with those obtained by Nawab *et al*., (2011).

Shah *et al.,* (2010) reported that the plant height, spike length, grain per spike, and 1000-grain weight increased with the integrated use in various amounts. The treatments which applied 25% N from FYM, 25% N from city waste, and 50% N from mineral fertilizer produced the highest grain yields. The treatments that applied 25% N from FYM, 25% N from poultry manure, or city waste, and 50% N from mineral fertilizer produced the same results. These results are supported by Iqbal *et al.,* (2002), and Arif *et al.,* (2006).

Ali *et al.,* (2011) studies the impact of various nitrogen levels on the development and yield of wheat crops at four different nitrogen rates, namely 0, 80, 130, and 180 kg ha-^{1}. With a seed rate of 100 kg ha-^{1}, the sowing date occurred during the previous week. The results demonstrated that raising the nitrogen levels over the control considerably enhanced the number of tillers per unit-^{1}, plant height, spike's length, number of grain spikes-^{1}, 1000-grain weight, and grain yield.

Singh *et al.,* (2011) the findings showed that the diversity of nitrification inhibitors in co-fertilizer caused growth characteristics, such as the number of tillers and plant height, to dramatically increase. These inhibitors slowly delivered nitrogen to the plant while reducing nutrient losses, making more nitrogen available to the plant. In comparison to treatment T_2, which applied a full dose of NPK through urea, a single superphosphate, and muriate of potash, the combined application of organic manures and inorganic fertilizers boosted the dry matter accumulation, number of grains Spike^{1}, grain yield, straw yield, and NPK uptake by wheat crop.

Brar *et al*., (2012) reported that a maximum wheat grain yield of 1.25 IW: CPE, which was statistically comparable to 1.0 IW: CPE, was achieved when irrigation was applied. This may be attributed to an increase in the number of seeds as a result of better soil moisture and nutrient availability. Similar findings were reported by Tripathi and Singh (2007) and Dhindwal *et al.*, (2006).

Yousaf *et al.,* (2014) reported on the impact of timing of irrigation and various nitrogen fertilization amounts on the agronomic performance of wheat. A total of 0, 80, 100, 120, and 150 kg ha^{-1} of nitrogen were added to the soil, with irrigation occurring 15, 20, 25, and 30 days following germination. In comparison to the control and other treatments, nitrogen applied at 120 and 150 kg N ha^{-1} and irrigation timing of 25 days after germination produced the highest plant height, most tillers, the greatest number of fertile tillers, and the highest yield.

Ahmad *et al.,* (2014) reported that adding organic manure with a high N level under frequent watering considerably boosted grain yield by more than 120% compared to control treatment. However, the number of tillers m^{-2}, number of grains $spike^{-1}$, and 1000-grain weight all increased significantly along with the increase in grain yield. Additionally, results demonstrated that applying organic manure and high N levels had a favourable impact on the harvest index. The positive effects of nitrogen on the characteristics of the yield components could be primarily responsible for the grain yield enhancement caused by the application of high N levels. In this respect, Ayoub *et al.,* 1994 Jan and Khan (2020).

Shahid *et al.*, (2015) reported that the considerable increase in grain yield and yield components following the application of poultry manure. Each increase in nitrogen application rate resulted in an increase in grain yield, grain crude protein content, the number of fertile tillers, spike length, flag leaf area, fresh weight, dry weight, plant height, and the number of grains.

Sheoran *et al.,* (2016) reported that the use of organic manures along with N and P fertilizers considerably improved all yield characteristics, including plant height, number of tillers/m of row length, spike length, and number of grains/spikes. When FYM, chicken manure, and press mud were combined with the appropriate doses of N and P, higher grain yields of wheat and were found.

Deo *et al.,* (2017) reported that the growth characteristics such plant height ,number of shoots per square metre and Leaf area index were shown to be significantly higher under the I_1 (critical stages) treatment. The I_1 (critical phases) and I_4 (1.0 IW: CPE ratio) treatments were shown to have higher total effective tillers m^{-2}, length of spike , harvest index (%), and test weight over both years. The highest grain and straw yields under I_1 (critical phases) treatment were observed throughout the period of the two years. This finding was supported the finding of Maliwal *et al*., (2000).

Verma *et al.,* (2018) reported that irrigation applied at 0.9 IW/CPE ratio (I_2) 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 Harvest Index proved significantly superior over I_1, I_4, and I_3 with treatment I_5 being the exception. Finding support the result of Bastia and Rout (2000).

Pal *et al*., (2020) reported that the number of shoots, plant height, dry matter accumulation, and yield-attributing characters such as number of grains spike-1, number of spike m-2, length of spike, test weight, grain, and straw yield by crop were significantly higher at the CRI stage (I_1), 0.6 IW/CPE ratio (I_2), and 0.8 IW/CPE ratio (I_3) than at the 1.0 IW/CPE ratio (I_4) moisture regime. Similar result find by Karim (2011) and Brahma *et al*., (2010).

Conclusion

The study's findings showed that the wheat crop produced considerably higher levels of plant height, dry matter, number of shoots, leaf area index, effective teller, grain production, straw yield, and harvest index when irrigation timing was appropriate. The application of both organic and inorganic nitrogen sources promotes wheat crop development and production.

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