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# Influence of growth regulators on growth, phenological traits and yield attributes of wheat [*Triticum aestivum* L.] under restricted irrigation condition

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**Abstract**

Water limiting condition creates imbalance or deficiency of growth regulators in plant, which leads toward reduce crop yield. The present investigation entitled "Influence of growth regulators on growth, phenological traits and yield attributes of wheat [*Triticum aestivum* L.] under restricted irrigation condition" was conducted during the *Rabi* season during 2017-18 and 2018-19 at Students' Instructional Farm, Nawabganj, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur-208002 (U.P.), India in randomized block design with three replications and exogenous application of growth regulators with control wheat plants *viz.*, Control, $GA_3$ 20 ppm, $GA_3$ 40 ppm, Alar 100 ppm, Alar 200 ppm, ABA 25 ppm, ABA 50 ppm, SA 50 ppm, SA 100 ppm, Kinetin 5 ppm and Kinetin 10 ppm on wheat variety (K1317) under restricted irrigation condition. Crop growth and yield attributes were assess during the experimentation. Study revealed that crop reduced growth and yield in term of plant height at maturity stage, number of leaves plant$^{-1}$ at all observation stage, days to anthesis, days to maturity, main spike length and grains weight plant$^{-1}$ under restricted irrigation, while, these parameters were improved with application of growth regulators. Maximum crop growth and yield traits were recorded with application of growth regulators $GA_3$ 40 ppm as compare to other treatments.

**Keywords:** Growth regulators, growth, yield and wheat

## Introduction

Wheat (*Triticum aestivum* L.) is one of the most important feeding cereals for one-fifth of the world population (FAO, 2011) [9]. It is a principal cereal crops grown worldwide and one of the important staples of nearly 2.5 billion of world population. Being next to rice, wheat constitutes one of the key sources of protein in least developed countries and middle-income nations and in terms of calories and dietary intake. In recent decades, increasing food demand and water deficit have created a challenge in terms of food security around the world (Reynolds *et al.,* 2011) [23]. Although great successes have been achieved in improving the yields of wheat crops, through crop breeding methods, we have a long way to go before we reach the theoretical wheat yield potential (20 t/ha) that is estimated by cereal physiologists (Evans, 1993) [8]. Water deficit has been, for a long time, the main environmental factor that impedes plant growth and crop productivity globally (Begcy and Walia, 2015) [4]. Wheat is an important drought-sensitive cereal crop whose growth and grain yield are severely affected by drought stress (Gao *et al.*, 2011) [12]. Water deficit decreases the growth of plants, influences various physiological and biochemical processes such as photosynthesis, respiration, metabolism of nutrients etc. Water shortage is one of the most limiting factors for wheat production worldwide (Lobell *et al.*, 2011) [17]. Therefore, good agricultural operation along with effective inputs and technology use, such as foliar spraying by plant growth regulators, is one of the best tools to improve physiological processes and plant performance under water deficit conditions.

Plant growth regulators are the most important internal factors for the regulation of plant growth in response to water stress factor. Studies have shown that plant hormones could regulate the partitioning and translocation of photoassimilates during grain filling (Ahmadi & Baker, 1999) [1]. PGRs were used in high-input cereal management to shorten the stem, thereby reducing lodging susceptibility. In consequences there are many reports that describe the various effects of PGRs on plants stand structure and yield formation of cereals (Pirasteh Anosheh *et al*., 2012) [22]. PGRs applications have been known to alter tiller and spikelet production as well as survival through changes that resemble day-length responses and gibberellin is a family of natural growth promoters of which $GA_3$ may be the most active in stimulating stem elongation (Davies 2010) [7]. Gibberellins (GAs) are a major class of plant hormones that regulate plant growth and development, from seed germination and stem elongation to fruit-set and growth (Swain and Singh 2005) [25]. Pan *et al.,* (2013) [20] reported that plant growth regulator such as $GA_3$, spray has considerable effects on seed quality and higher wheat seed yield due to increasing in spikelet in spike, number of seeds and grain filling percentage. Increase in fresh and dry weights of wheat grain following alar treatment may presumably be explained on the basis that alar enhances accumulation of carbohydrates within the grain particularly during the early stages of grain development observed by (Mansour *et al*., 1988) [18]. Water deficit also increases abscisic acid levels in leaves and spikelets of wheat, which reduces the number of seeds. The exogenous application of abscisic acid was found to reduce chlorophyll in flag leaves, whereas remobilization and rate of grain filling were enhanced by increasing abscisic acid (Yang *et al.,* 2006) [26]. Salicylic acid (SA) is a synthetic plant growth regulator which is important for growth and productivity (Arfan *et al.,* 2007) [3]. SA is the major solute involved in cell osmotic water uptake to maintenance of cell turgor pressure and the regulation of stomatal opening (Hafez and Farig, 2019) [15]. A main physiological impact of SA is increasing internal $CO_2$ exchange during photosynthesis and it has also a regulatory role in physiological processes, such as photosynthesis, transpiration, nutrient uptake, chlorophyll synthesis and plant development. Appropriate SA application can improve a crop's tolerance to water deficit (Khan *et al.,* 2018) [16]. Cytokinins have been shown to play an important role in the transportation of assimilates to wheat spikes (Darussalam *et al.,* 1998) [6]. As well, cytokinins are required for cell division during the early phase of grain filling (Yang *et al.,* 2000) [25].

## Materials and Methods

The field experiment was conducted to study the influence of growth regulators on growth, phenological traits and yield attributes of wheat [*Triticum aestivum* L.] under restricted irrigation condition at Students' Instructional Farm of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur - 208002 (Uttar Pradesh) during the 2017-18 and 2018-19. Soil of the experimental site was normal in nature (pH 7.4), field capacity 20.00% and the experiment was laid down in randomized block design with three replications. Wheat variety K1317 were taken for study which was sown at timely condition and wheat plants were irrigated first at CRI stage and second before milky stage of crop plant. Various growth regulators *viz*., $GA_3$ (20 and 40 ppm), Alar (100 and 200 ppm), ABA (25 and 50 ppm), SA (50 and 100 ppm) and Kinetin (5 and 10 ppm) were applied as exogenous application, first at 30 days after sowing and second at anthesis stage. All the observation were taken at different stages of wheat plant. Growth parameters such as plant height and number of leaves plant$^{-1}$ was measured with the help of meter scale and by counting leaves from each tiller at different growth stages. Phenological parameters i.e, days to anthesis were assessed by counting the number of days taken from sowing to the days when 75 per cent plants show anthers emergence and days to maturity of crop was assessed for each treatments by visual appearance of grains and color of leaves. The plants were harvested separately from control and other growth regulators treated plots. Thereafter, main spike length and grains weight plant$^{-1}$ were recorded in randomly selected plants. All the data on growth, phenological and yield traits were statically analyzed by the methods suggested by Fischer (1937) [10].

## Results and Discussion

The effect of exogenous application of growth regulators on wheat variety K1317 respond differentially to restricted irrigation in the form of various changes in their growth, phenological and yield traits. In present investigation, plant height at maturity stage was found significantly higher treated with $GA_3$ 40 ppm (95.36) being at par with Kinetin 10 ppm (94.67), $GA_3$ 20 ppm (94.45), Kinetin 5 ppm (94.33), SA 100 ppm (93.61) and S A 50 ppm (92.43) and significantly lower value treated with ABA 50 ppm (88.13) followed by ABA 25 ppm (88.80) in 2017-18. While, in 2018-19 higher plant height was found significantly influenced with $GA_3$ 40 ppm (95.83) being at par with Kinetin 10 ppm (95.26), $GA_3$ 20 ppm (94.96), Kinetin 5 ppm (94.78), SA 100 ppm (94.15) and SA 50 ppm (92.81) and lower plant height was found with ABA 50 ppm (88.34) followed by ABA 25 ppm (89.05) in 2018-19. Rest treatments had plant height in between 89.15 to 91.05 and 89.56 to 91.38 during 2017-18 and 2018-19, respectively (Fig. 1). Golldack *et al.,* (2013) [13] reported that in higher plants, abscisic acid and gibberellic acid antagonistically regulate various developmental stages, such as seed dormancy and germination, root growth, leaf development, flowering time, plant height and responses to environmental cues, such as abiotic stresses.

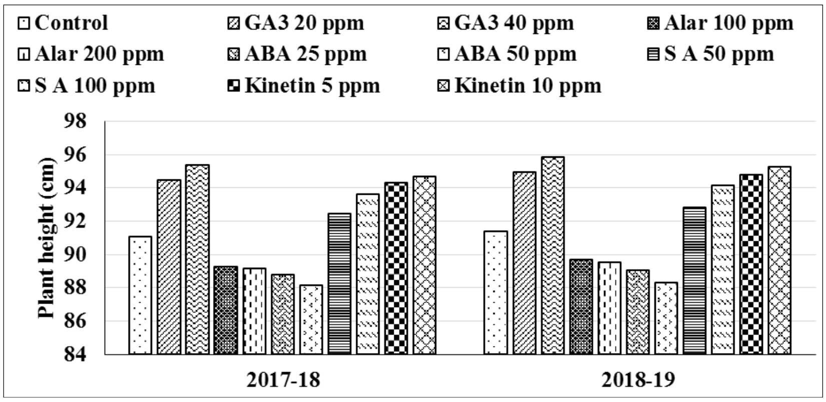


**Fig 1:** Effect of growth regulators on plant height of wheat at maturity stage

Data regarding number of leaves plant$^{-1}$ were counted at three different days after sowing of wheat i.e., 30, 60 and 90 DAS are presented in Fig. 2. It is clear from the data that the application of growth regulators significantly increased number of leaves plant$^{-1}$ at 60 and 90 days after sowing during both year of studies. Leaves number at 30 DAS did not show significant but statistically higher with the different concentration of growth regulators as compare to control. Higher leaves number was found with $GA_3$ 40 ppm (7.33 and 7.35) fallowed by Alar 200 ppm (7.21 and 7.23), Kinetin 10 ppm (7.17 and 7.19) and S A 100 ppm (7.07 and 7.09) and lower the number of leaves plant$^{-1}$ with control (6.61 and 6.63) during both years, respectively. At 60 DAS, all growth regulators significantly affected number of leaves plant$^{-1}$. It was noticed that the highest recorded number of leaves plant$^{-1}$ was obtained by exogenous application of $GA_3$ 40 ppm (24.26 and 24.28) being at par with Alar 200 ppm (24.21 and 24.22), Kinetin 10 ppm (23.83 and 23.84), S A 100 ppm (23.75 and 23.76), Kinetin 5 ppm (23.13 and 23.15) and $GA_3$ 20 ppm (22.81 and 22.83) while, the lowest value was recorded with control (20.43 and 20.45) and remaining doses of the treatments had number of leaves plant$^{-1}$ in between 20.74 to 22.17 and 20.75 to 22.18 during 2017-18 and 2018-19, respectively. Similar tendency of results as 60 DAS were also found at 90 DAS but the number of leaves plant$^{-1}$ was slightly increased with effects of growth regulators in comparison to 60 DAS. $GA_3$ 40 ppm (25.17 and 25.19) recorded significantly higher value which was being at par with Alar 200 ppm (24.95 and 24.97), Kinetin 10 ppm (24.72 and 24.74), S A 100 ppm (24.18 and 24.20), Kinetin 5 ppm (23.64 and 23.65) and $GA_3$ 20 ppm (23.34 and 23.35) during both years of experiment, respectively. The lower value was found with control (21.03 and 21.04) and rest treatments had number of leaves plant$^{-1}$ in between 21.23 to 22.81 and 21.23 to 22.82 in 2017-18 and 2018-19, respectively. Our findings is also in respect of Meera Shrivastava (2003) [19] in Indian mustard.

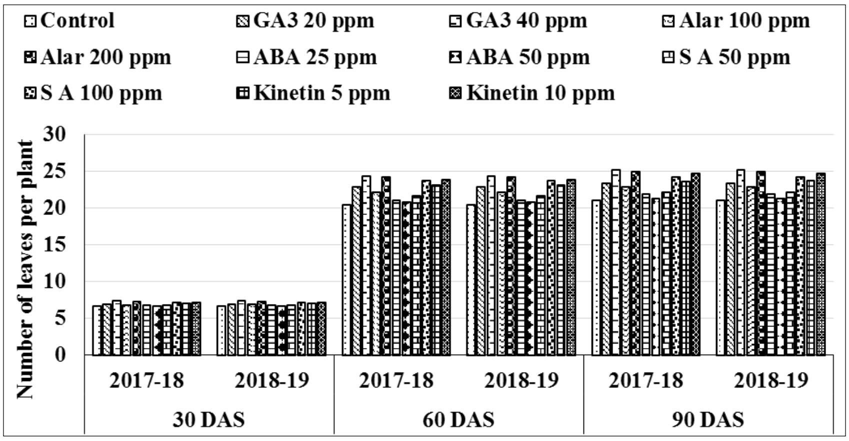


**Fig 2:** Effect of growth regulators on number of leaves plant$^{-1}$ of wheat at different growth stages

Data pertaining to days to anthesis (Fig. 3) clearly revealed that it varied non-significantly due to application of growth regulators during both year of studies on wheat crop under restricted irrigation condition. Response of growth regulators *viz.*, Alar 200 ppm (84.00, 84.36), Kinetin 10 ppm (83.72, 83.89), Kinetin 5 ppm (83.44, 83.72), Alar 100 ppm (83.26, 83.68), ABA 25 ppm (83.13, 84.57), S A 100 ppm (82.54, 82.85), S A 50 ppm (82.35, 82.66) and ABA 50 ppm (82.17, 82.54) took longer days while, $GA_3$ 40 ppm (81.56, 81.45) and $GA_3$ 20 ppm (81.73, 81.64) took shorter days for anthesis as compare to control (81.91, 81.86) during 2017-18, 2018-19, respectively. Data regarding days to maturity as affected by foliar application of growth regulators are depicted in Fig. 3. The perusal of data reveal that growth regulators *viz.*, Alar, Kinetin, Salicylic acid and Abscisic acid were delayed the maturity whereas, gibberellic acid served as the early maturity of the crop grown under restricted irrigation. The maximum days to maturity was found with response of Alar 200 ppm (126.85, 126.91) followed by Kinetin 10 ppm (126.57, 126.74), Kinetin 5 ppm (126.33, 126.56) and Alar 100 ppm (126.13, 126.32) and minimum days to maturity was recorded with $GA_3$ 40 ppm (124.39, 124.43) as compare to control (124.65, 124.79) respectively, during both years of experiment. Peleg *et al.* (2011) [21] and Chaves *et al.*, (2002) [5] reported that altered crop phenology under stress is an important indicator for sustaining the grain yield in cereals.

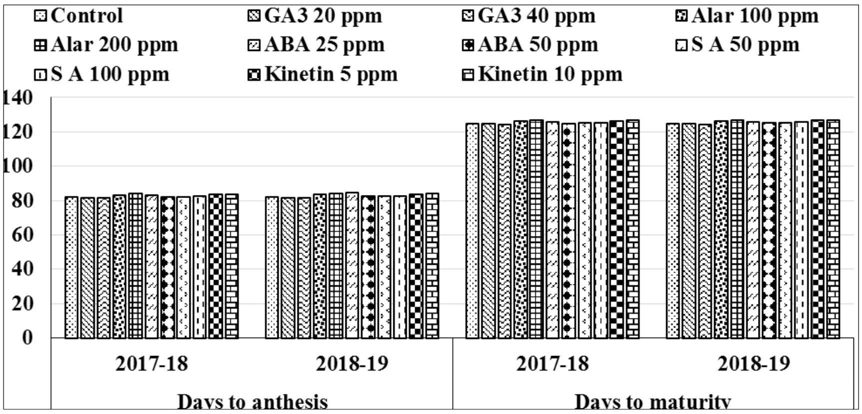


**Fig 3:** Effect of growth regulators on days to anthesis and days to maturity of wheat

The perusal of data on main spike length (Fig. 4) reveal that all the treatments registered significantly increase this traits. Although, maximum increase in main spike length was recorded with effect of $GA_3$ 40 ppm (11.43 and 11.45) being at par with Alar 200 ppm (11.32 and 11.33) and Kinetin 10 ppm (11.24 and 11.26) while, minimum length of main spike was noted with control (9.93 and 9.94) followed by ABA 50 ppm (10.15) during 2017-18 and 2018-19. Rest of the treatments had main spike length in between 10.38 to 11.13 in first year and 10.39 to 11.15 in second year of experiment. These findings are in congruence with earlier reports by Foulkes *et al.* (2010) [11] and Ameer *et al*. (2009) [2].

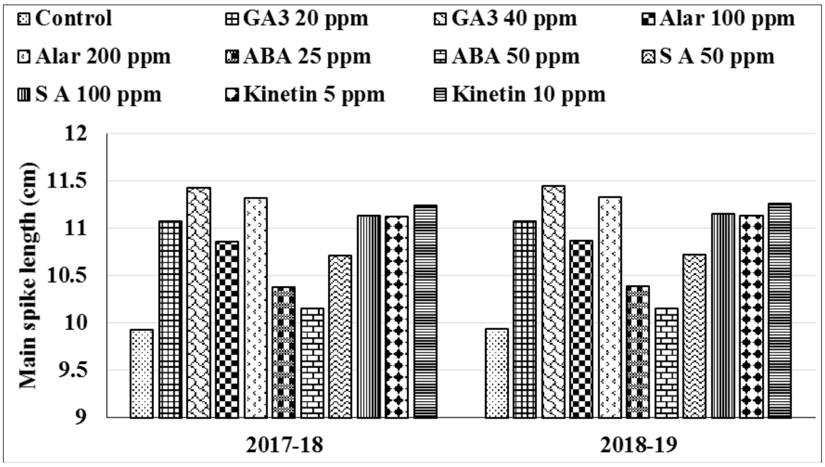


**Fig 4:** Effect of growth regulators on main spike length of wheat at harvest stage

Data concerning grains weight plant$^{-1}$ were recorded at the time of harvest of wheat plants are furnished in Fig. 5 which revealed that value of this trait were observed in the range of 10.94 to 13.28 in the first year and in second year it varied from 10.95 to 13.30 among all tested different growth regulators on wheat variety K1317 grown under restricted irrigation condition. The highest grains weight plant$^{-1}$ was produced with influence of $GA_3$ 40 ppm (13.28 and 13.30) which was being statistically at par with Alar 200 ppm (13.19 and 13.20), Kinetin 10 ppm (13.09 and 13.11) and S A 100 ppm (12.95 and 12.96) in 2017-18 and 2018-19 as compared to other treatments. While, the lowest value of it was noted in control (10.94 and 10.95) followed by ABA 50 ppm (11.54 and 11.55) during first and second year of experiment. Remaining treatments gave grain weight 11.87 to 12.74 and 11.88 to 12.75g per plant, respectively during first and second year of experimentation. The findings in wheat Hadole *et al.,* (2002) [14] are also in accordance with our results.

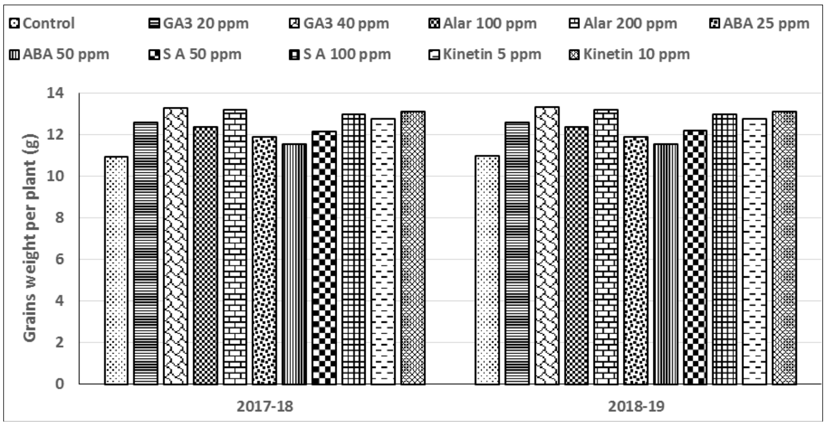


**Fig 5:** Effect of growth regulators on grains weight plant$^{-1}$ of wheat at harvest stage

## Conclusion

It was concluded that crop growth, days of growing period and yield attributes of wheat were affected by exogenous application of growth regulators under restricted irrigation condition. Based on the performance of wheat variety K1317 at different growth regulators with different doses, it is suggested that growth regulators *i.e.*, $GA_3$ 40 ppm, Alar 200 ppm, Kinetin 10 ppm and S A 100 ppm can play crucial role in sustaining to growth and yield feature of wheat under restricted irrigation condition.

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