



Yield optimization of late sown wheat through special plant growth regulators

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Regardless of the application of inputs i.e. chemical fertilizers, plant protection measures and irregular irrigations, wheat cultivated areas of Pakistan are commonly low yielded due to late seeded of wheat under our cotton-wheat cropping system. Contemporary experiment in field was laid out to examine the response plant growth promoters through artificial application on late seeded wheat at experimental area of Faculty of Agriculture, University of Agriculture, district Faisalabad in wheat sowing season 2019-20. There were four plant growth promoters viz. Indole Acetic Acid (IAA); Moringa Leaf Extract (MLE); Gibberellic Acid (GA₃) and Indole Butyric Acid (IBA) were artificially applied with various approaches viz. seed priming and spray application (both); seed priming and spray application. This experiment was conducted in factorial arrangement of randomized complete block design (RCBD) replicated thrice. The size of plot of experiment was remained 4.5 m×2.4 m (L*W). Outcomes of experiment indicated that priming technique of wheat seed with GA₃ eloquently improved seed emergence attributes i.e. mean germination time (MET), time to start germination, time taken to fifty percent germination and index of germination as compared to Moringa Leaf Extract and Indole Acetic Acid. Similarly combination of both priming + spray application of moringa extract eloquently enhanced yield attaining parameters i.e. No. of grains per spike, No. of productive tillers, grain yield and 1000-grain weight by 16%,28%, 29% and 18%, respectively, in comparison to Gibberlic acid. Outcomes of this experiment shown artificial treatment of IAA, IBA and MLE eloquently improved the yield of late seeded wheat crop. This advantage was credited to more accumulation of metabolites, healthy growth and development, lower oxidative damage and relative water contents. Benefit cost ration analysis shown that moringa extract was the greatest economical for increasing the wheat production and clear profit of late seeded wheat. In said view, exogenous use of plant growth promoters eloquently increased the production of late seeded wheat in Pakistan.

Keywords: Foliar, Growth Promoters, Priming, Wheat, Gibberellic Acid, Moringa, Indole Butyric Acid

INTRODUCTION

Globally wheat (*Triticum aestivum* L.) is the main basic food of the mainstream of the people and it is furthermore the major diet source in Pakistan. Wheat is the main cereal crop delivers higher than 60% of the total required protein and about 50% of the required carbohydrates to the world. Around 21% of the world food

is reliant on this imperative cereal wheat crop. During wheat season 2018-19 Pakistan cultivated wheat on 8.81 million hectares land and production is 25.20 million tons of food (Economic Survey of Pakistan, 2019).

The main yield limiting factors of the wheat production are poor plant protection measures, low quality unauthorized seedless nourishments of inorganic at

proper time, irrigation scarcity and delaying in sowing (Sattar et al. 2010; Abouziena et al. 2008; Farooq et al. 2008). One day late in seeding of wheat after recommended date i.e. 20th November declines wheat seed grain by 36 kg per ha per day (Hussain et al. 1998). In south Asia, late seeded wheat is commonly experienced due to pertaining cotton-wheat and rice-wheat system of cropping. Under late seeded conditions all the wheat growth stages i.e. crown root initiation, tillering of wheat, earing and the last grain filling, are badly affected by the condensed growing period (Khan et al. 2009). Around 42% decreasing in the yield of wheat was informed due to late sown of wheat (Subhan et al. 2004).

The plant growth promoters (PGPs) have much importance in plant physiology and anatomy. The responses of plant growth promoters (PGPs) in priming are faster and reduces the times to seed emergence, which improves crop growth and development and hence increased the wheat grain yield and biological yield, principally under tense field conditions (Halmer, 2004). Gaballah and Mandour (2000) reported that if plant promoters (PGPs) used at optimal dose, PGPs may be regulate tissue swelling, cell division of plant, their cell elongation, shoot development, formation of adventitious types of roots, callus origination, induction of embryogenesis and growth. Artificial application of promoter/ hormones on wheat crop is a useful methodology to minimize the losses of terminal heat stress at grain filling stage.

Priming with MLE has been demonstrated a prospective technique to boost the emergence of seedling in wheat crop (Yasmeen et al. 2012). Basra et al. (2011) narrated through his experiment that similar outcomes and decided that use of moringa extract improved 1K-seed weight of wheat crop. MLE primed seed of wheat indicated, lessening in average emergence time, more emergence index and required lowest time to get fifty% emergence. In another experiment Yasmeen et al. (2013) reported the artificial application of MLE indications of better grain yields, total dry matter and biological yield under late sown conditions.

Plant hormone Indole Acetic Acid exogenously application inspired the plant growth and development through enhancing photosynthetic actions, expanding leaf area and strong relationship of source sink for starches accumulation (Ritenour et al. 1996). Similarly, Chhun et al. (2004) find results of IBA (Indole Butyric Acid) is rooting hormone and used commonly for cuttings of plant and their growth and structure, emerging seeds, young leaves development, root density and elongation, promote secondary roots development, shoot tissue, pods per plant enhances, seed weight and ultimately crop yield production.

Bideshki et al. (2013) presented that, IBA improved photosynthesates colors of garlic.

Gibberellins (GA₃) are enormous group of plant hormones of endogenously integrated that motivate

expansion of cell division, cell elongation; ultimately it goes for lengthening of stem (Godwin and Mercr, 1988). If a Hormonal production of gibberellic acids is restricted at various stages in pulses and cereal crops it disturbs the physiological mechanisms of plant. It is affirmed that the dry and fresh weight of seedlings increased through application of GA₃ at optimal concentration (Rademacher et al. 1992). Afzal et al. (2005) described that under stressful conditions priming of wheat seed with GA₃ prominently better root shoot ratio.

Basra et al. (2006) reported that technique of priming is pre-soaking in solution management of seed which reduces the time between sowing and emergence of seedling that outcome in the identical seed stand establishment of crop. Halo-priming, hydropriming, osmo-conditioning and hormonal-priming are various forms of priming. The seed priming is a beneficial approach for the speedy and symmetrical germination of wheat seeds (Farooq et al. 2007). In priming technique, seeds of any crop are pre-soaked in numerous priming agents in liquid with high osmotic potential. Farooq et al. (2007) describes to prevent the wheat seeds from imbibing in sufficient water for seed radicle projection, consequently swinging the seeds in the interval phase. Priming technique has been usually applied to decrease the time between seed planting and seedling beginning and to coordinate development.

Keeping in scenario above said declared opinions, a field study was laid out to estimate the contribution of exogenous application plant promoters/ enhancers with various useful approaches on late seeded wheat falling in the agro climatic environments of district Faisalabad by the given below objectives:

To investigate the reaction plant growth promoters to late seeded wheat.

To select the most suitable and economic plant growth promoters for wheat under late seeded conditions.

To find out the utmost efficient application approach of crop growth promoters on late seeded wheat.

MATERIALS AND METHODS

Seed source

Wheat cultivar Fakhar e Bhakkar 2017 was obtained from Arid Zone Research Institute, Bhakkar, Punjab, Pakistan.

Site of Experiment

This experiment was laid out at research area of Department of Agronomy, University of Agriculture Faisalabad, at altitude of 184 m. Total nitrogen, organic matter, potassium and obtainable phosphorus were .071%, 0.69%, 181 ppm and 12.9 ppm respectively. The pH of experimental block soil paste was 8.1. Agro-climatic conditions of Faisalabad are arid to semi- arid conditions.

Investigation

The trial was conducted in factorial arrangements under randomized complete block design (RCBD) and using three replications. The experiment was conducted during 2019-20. The experimental plot size was kept 4.5 m × 2.4 m (L*W). The crop was seeded in the end of December 2019 with hand drill consisted single row, seed rate was used @125 kg per ha and retaining 30 cm space between row to rows. The fertilizer dose of N @125 kg and P₂O₅@ 55 kg ha⁻¹ was applied at recommended level. Fertilizers source are used as whole urea (46% N) and diammonium phosphate (DAP) (18% N, 46% P₂O₅). The left over half dose of nitrogen was used in two splits one at tillering stage and 2nd dose applied at spike initiation, respectively. Plant protection measures were adopted at recommended level. Irrigation was applied at required stages. Trial consisted with following treatments,

Factor A: Plant growth regulators (PGRs)

- P₁: Indole acetic acid (IAA)
- P₂: Moringa leaf extract (MLE)
- P₃: Gibberellic acid (GA₃)
- P₄: Indole butyric acid (IBA)

Factor B – Application Approaches (Methods)

- M₁: Wheat seed priming + Spray application
- M₂: Wheat seed priming
- M₃: Spray application

Wheat seed priming was done by preparing 50 ppm solution of each plant growth regulator in water and the ratio of solution to seed was 5:1. Wheat seeds were primed in the PGRs solution for 24 hours and then shade dried for 12 hours prior to sowing. Foliar application was done by preparing 25 ppm solution of each plant growth regulator and volume of solution was calculated by calibration prior to application.

Data on seedling establishment (time to initiate emergence, time taken to fifty% emergence, and germination index(%) and mean germination time (MET)) were recorded by adopting standard procedures.

Emerged seeds out of total were counted on daily basis and experiment was investigated daily conferring to the sapling assessment Handbook of Association of Official Seed Analysts published in 1990 to calculate time to start beginning in terms of days. Following formulae were used to calculate other germination parameters.

Time required for fifty% of seed emergence of wheat (E₅₀), was formulated giving to the below given formulae of 50% emergence.

$$E_{50} = t_i + \left[\frac{N/2 - n_i}{n_j - n_i} \right] (t_j - t_i)$$

In this formula symbol N is numeral of last emergence counting and symbol n_i, n_j accumulative sum of seeds appeared at adjacent time (days) while t_i and t_j where n_i < (N+1)/2 < n_j.

In case of MET was formulated according to given below formula described by Ellis and Roberts formulated in 1981:

$$MET = \frac{\sum Dn}{\sum n}$$

In this equation shows the No. of wheat seeds, they were emerged on D (day) and the symbol D shows the numeral of days start counted from the start of emerging day.

Farooq et al. (2007) derived formula for vigor of seed emergence was observed at the 4th day of planting when the wheat seeds are emerged. This is the percentage of emerged plants 4 days, after sowing relation to total quantity of wheat seeds examined.

$$EI (\%) = \frac{\text{Number of plant emerged from soil 4 days later planting}}{\text{Total number of wheat seeds planted}} \times 100$$

Data on wheat yield contributing attributes was observed from 10 unbiased selected plants taken from each treatment and each replication and then their average was calculated. A unbiased sample of spikes was taken from each plot, and then weighed on an electric balance 1000-grains were counted manually. For productive tillers per m² were counted from three randomly selected sites from each plot of averaged crop was harvested, this harvested crop tied into bundles in their own plots. Though weighing biological yield of each samples were recorded. Each trial plot was threshed manually to determine seed grain yield and then converted this m² into ton ha⁻¹.

Statistical Investigation

The collected data was statistically examined on computerized software Statistics 8.1 by using Fisher's analysis of the variance technique. In this treatment's means differences were compared by applying LSD (least significant difference) test @ 5% of significance level (Steel et al. 1997.).

RESULTS AND DISCUSSION**Seedling establishment**

Response of plant growth promoters on sprouting attributes (time to initiate emergence, time required to fifty% seed emergence, germination index and mean germination time commonly famous MET is showed in Table. 1. This is vibrant from data regarding growth promoters had a noteworthy result on all germination attributes. Minimum time to start emergence, time taken to fifty% emergence, germination index and mean germination time were recorded under GA₃ (8.16 days), GA₃ (11.02 days), IBA (31.04) and GA₃ (11.74 days), respectively which indicated that GA₃ was the most efficient in enhancing germination in late sown wheat as compared to MLE, IAA and IBA. However, there was no

significant difference for time taken to fifty% emergence, time to initiate emergence, germination index (%) and average emergence time among IAA and IBA (Table. 1).

Wheat seed sprouting and his seedling growth, both have been enhanced by the seed soaking in solution of GA₃ (Sakhabutdinoa et al. 2003; Khan et al. 2004; Hamayun et al. 2010)

Germination plays a significant role in crop production because seed emergence is an imperative period of seedling stand and the crop establishment. Nevertheless, it be influenced by on the relations between seed quality and seedbed surroundings is important. Seed soaking with solution is unique one of the supreme essential functional treatment which increases the wheat seed

performance & delivers quicker and symmetry propagation (Shahbaz et al. 1998).

The soaked wheat seeds with gibberlic acid (GA₃) bounce earlier, Distinguished, added uniformity and sometime good germination and well seedling establishment and growth of plant (Bradford, 1986). Basra et al, (2005) also supports our results he describes increased total and reductive sugars content in wheat through enhancing nitrogen uptake, have been related to enhanced root propagation and improved α-amylase movement in starch hydrolysis in seed priming with promoters.

Table 1: Individual comparison of means of treatment for germination attributes

Plant growth promoters	Germination attributes			
	Time taking to initiate emergence in days	Time required to fifty percent emergence in days	Mean germination time(MET) in days	Germination (%) index
Indole acetic acid	9.76 a	11.10 ab	11.81 b	31.48 c
Moringa leaf extract	9.46 a	11.17 a	11.88 a	32.61 b
Gibberillins	8.16 b	11.02 b	11.74 c	33.24 a
Indole butyric acid	9.16 a	11.03 b	11.78 bc	31.04 c
LSD value	0.62	0.10	0.06	0.60

Table. 2: Individual comparison of treatment means for yield attributes

Treatments Plant Growth promoters	Yield attributes			
	No. of Productive tillers per m ²	No. of grains spike ⁻¹	1000 grain/seed weight in gram	Seed yield (ton per hectare)
Indole acetic acid	272.89 A	38.22 A	39.90 B	3.86 A
Moringa leaf extract	273.78A	38.88 A	42.20 A	3.92 A
Gibberillins	250.49 C	33.00 C	37.61 D	3.27 C
Indole butyric acid	258.04 B	35.22 B	39.07 C	3.64 B
LSD value	3.8466	1.8071	0.8289	0.0722
Application approaches (Method)				
Seed priming + Spray	281.20 A	36.750	39.73	3.74 A
Seed priming	267.00 B	36.50	39.40	3.61 C
Spray application	243.20 C	35.75	39.96	3.67 B
LSD value	3.3313			0.0625
PGRs* Method				
IAA*priming+foliar	297.07 b	39.33	39.61 b-d	3.95 b
IAA*priming	282.67 c	38.33	39.43 b-d	3.81 cd
IAA*foliar	238.93 i	37.00	40.67 bc	3.82 cd
MLE*priming+foliar	305.33 a	39.66	43.39 a	4.09 a
MLE*priming	274.40 d	38.66	40.85 b	3.78 cd
MLE*foliar	241.60 hi	38.33	42.37 a	3.91 bc
GA ₃ *priming+foliar	250.67 fg	32.66	37.55 ef	3.17 h
GA ₃ *priming	253.33 ef	33.33	38.62 de	3.34 g
GA ₃ *foliar	247.47 fgh	33.00	36.65 f	3.31 g
IBA*priming+foliar	271.73 d	35.33	39.26 cd	3.75 de
IBA*priming	257.60 e	35.66	38.70 de	3.51 f
IBA*foliar	244.80 g-i	34.66	39.26 cd	3.65 e
LSD value	6.6625		1.4357	0.1250

Yield and yield components

Response of plant growth promoters under different application approaches on yield and yield contributing parameters of wheat is presented in Table 2. It is described from the data that PGRs, application approaches & interaction had a prominent response on number of productive tillers per m² and economic yield of wheat. While 1K seed weight & No. of grains spike⁻¹ were clearly increased only in case of PGRs. The artificial application of moringa extract commonly known as MLE spray enhanced economic and total bio yield in situation of late seeded wheat, and wheat grain yield augmented due to positive increase of number of grains per spike of wheat and 1k-grain weight (Yasmeen *et al.* 2012).

Wheat seed soaking and spray application of Moring Extract excellently enhanced yield comprehending parameters i.e. No. of grains per spike, No. of productive tillers, grain yield and 1000-grain weight by 12%, 23%, 16 % and 13%, respectively.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

All authors have equal contribution in performing this research.

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