Plant Archives Vol. 25, Supplement 2, 2025 pp.3077-3084 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.supplement-2.395

EFFECT OF GROWTH REGULATORS ON GROWTH RESPONSE AND YIELD COMPONENT OF DIFFERENT WHEAT VARIETY

Rajesh Kumar Meshram[1]*, P. K. Mishra[2], Vikas Jain[3] and Kaushalesh Kumar Mishra[1]

[1]Zonal Agricultural Research Station, Jawaharlal Nehru Krishi Vishwavidyalaya Powarkheda-461110, Narmadapuram, India.

[2] Department of Agronomy, College of Agriculture, Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur-482004, India.

[3]College of Agriculture, Jawaharlal Nehru Krishi Vishwavidyalaya, Powarkheda-461110, Narmadapuram, India.

*Corresponding author E-mail: rkmagro06@gmail.com

(Date of Receiving : 23-05-2025; Date of Acceptance : 30-07-2025)

ABSTRACT

A field experiment was conducted at Zonal Agricultural Research Station, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Powarkheda, Narmadapuram (Madhya Pradesh) during *rabi* seasons of 2020-21and 2021-22 to study the effect of growth regulators on growth and yield of different wheat variety. The experiment was laid out in a split plot design with four wheat variety (GW 322, Sujata, C 306, MP 1202) as main plot and different level of cycocel and ethephon (cycocel @1000 ppm, cycocel @1500 ppm, ethephon @10 ppm, ethephon @30 ppm and control) in sub-plots, with three replications. Results revealed that variety MP 1202 recorded the highest number of tillers (611.65 m^{-2}), dry weight (1217.84 g m^{-2}) and the maximum grain yield (51.81 q ha^{-1}). Application of cycocel @ 1500 ppm significantly reduced plant height and increased dry matter accumulation (g m^{-2}), leaf area index (LAI). The maximum grain yield (49.99 q ha^{-1}) which was significantly superior over all treatments except ethephon @ 30 ppm.

***Keywords* :** Wheat variety, growth regulators, tiller, dry matter, yield.

Introduction

Wheat (*Triticum aestivum* L.) is one of the major cereal crops of the world and plays an important role in food and nutritional security of large part of global population. It provides 55% of the carbohydrates, 21% of the food calories and 20% of protein for more than 4.5 billion people in 94 countries (Breiman and Graur 2008).

In India, wheat has been cultivated in 31.13 and 30.47 million hectares with the production of 109.59 and 106.84 million tonnes with national average productivity of 3521 and 3507 kg per hectare during the year 2020-21 and 2021-22. In the state of Madhya Pradesh, area, production and productivity are 6.08 and 6.50 million hectars, 18.18 and 21.33 million tonnes and 2989 and 3449 kg per hectare during 2021and 2022 (Agricultural statistics at a glance, 2022).

In India, the range of grain yield loss in wheat is 12-66% due to lodging. (Raj kumara., 2008). Lodging is influenced by many environmental factors (wind, rainfall, topography), soil type, many morphological and anatomical plant traits (plant height, internodal length, stem diameter, wall thickness as well as breaking strength, plant density, culm anatomy and chemical composition of stem and root characters. In addition, head density and size also affect lodging in crops. In India, wheat is mostly sown on flat beds and is irrigated through flooding and occurrence of high wind velocity at grain filling stage makes wheat crop prone to lodging. To check this farmer usually skip the last irrigation at grain filling stage which results in poor grain filling and ultimately lower yields.

Lodging problem can be solved by using growth retardants to prevent the rapid increase of plant height, without any adverse effect on yield attributes and quality of crop. Growth retardants reduce plant lodging and improve plant architecture and thus increase solar radiation capturing and other environmental resources. These morphological changes can affect the assimilate partitioning, improve seed filling and consequently the physiological quality of seeds (Zagonel and Fernandes, 2007). Chlormequat chloride (Cycocel) is widely used as a growth retardant in the cultivation of cereals. It prevents or reduces the synthesis of gibberellins, a plant hormone responsible for the lengthening of the stem (Pirasteh-Anosheh *et al*., 2014).

The use of ethephon as a growth retardant has been shown for controlling lodging of cereal and grain crops. Ethephon is a synthetic plant growth regulator that undergoes chemical biodegradation at pH greater than 4.1 in cell cytoplasm to release ethylene. (Urwiler and Stutte, 1986). Ethrel regulates plant height by slowing cell division in shoots without altering morphology (Hilli *et al*., 2010)

Plant growth regulators (PGRs), such as cycocel and ethephon, play a crucial role in modifying crop growth and development. However, limited studies are available on their interaction with different wheat cultivars in the central Indian agro-climatic region. Therefore, the present study was undertaken to evaluate the effect of cycocel and ethephon on growth dynamics and yield performance of selected wheat variety.

Materials and Methods

Powarkheda is situated in the Central Zone of India has a tropical and sub-tropical climate. This Centre is situated on the banks of the holy river Narmada at 77^{o}.42' N Latitude, 22^{o}.40'E Longitude and 299 m above mean sea level Altitude. It possesses deep black soil Vertisol having pH 7. The climate of locality is characterized as typically tropical sub-humid, which is featured by hot dry summer and cool dry winter. It is classified as “Malwa plateau and Narmada sown hills’’ agro-climatic zone.

The weekly meteorological data on mean maximum and minimum temperature, rainfall, relative humidity and sunshine hours during field experimentation (November to April 2020-21 and 2021-22) were recorded from the Meteorological Observatory, Zonal Agricultural Research Station, Powarkheda, Narmadapuram. In the agricultural season of 2020-21, weekly maximum temperature varied from 18.36 ^{0}C to 40.24 ^{0}C while minimum temperature varied from 6.93 ^{0}C to 20.64 ^{0}C. The maximum temperature was varied from 18.91 ^{0}C to 42.56 ^{0}C during the year 2021-22, while the minimum temperature varied from 5.2 ^{0}C to 23.03 ^{0}C. The relative humidity was 88.56 % in the morning and 32.36 % evening in the 1st year, while it was 87.86 % in morning and 29.73 % evening in the 2nd year of experimentation. The total rainfall 90 mm and 52 mm was received during the first and second year respectively. The crop was exposed to a total sunshine duration of 184.67 and 180.13 hours during the total life span of the crop in the first and second years respectively. All weather parameters were almost favourable for wheat. The texture of the surface soil of the experimental field was deep black soil Vertisol, having pH 7, containing 49.26% sand, 24.24% silt and 26.50% clay. The organic carbon content was 0.48% and the soil was low in available N (95 kg ha^{-1}), medium in available P (21.72 kg ha^{-1}) and high in available K (300.26 kg ha^{-1}). The experiment was laid out in a split plot design with four wheat variety (GW 322, Sujata, C 306, MP 1202) as main plot and different level of growth regulator (cycocel @1000 ppm, cycocel @1500 ppm, ethephon @ 10 ppm, ethephon @ 30 ppm and control) in sub-plots, with three replications. The N:P:K,120:60:40 kg ha^{-1} was applied through diammonium phosphate, urea and muriate of potash. Half of nitrogen and full dose of phosphorous and potash were applied as basal and remaining nitrogen were given at 1st irrigation and 2nd irrigation. The experiment was sown on 10th and 11th Nov. during the year 2021 and 2022. Data were analysed by using OPSTAT software available at CCS Haryana Agricultural University website (Sheoran *et. al*., 1998). The results are presented at five per cent level of significance (p=0.05) for making comparison between treatments.

Results and Discussion

Growth parameters

Plant height at different periodical stages is presented in Table 1. The plant height increased with the advancement of crop growth up to maturity. The plant height increasing rate was maximum between 60-90 DAS as compare to 30-60 DAS, marginal increment was observed up to maturity. The highest plant height was observed significantly in Sujata than all other variety. The lowest plant height significantly was recorded in GW 322 as compare to remaining variety. Plant growth regulators has significant effect on plant height at all stages except 30 DAS. The minimum plant height of 91.38 and 95.92 cm was recorded with cycocel @ 1500 ppm at 90 DAS and harvest followed by ethephon @ 30 ppm (93.08 and 97.19 cm) and cycocel @ 1000 ppm (93.55 and 97.54 cm). The plant height was significantly decreased by 8.57 % with the application of cycocel @ 1500 ppm at maturity. The interaction between wheat variety and plant growth regulators was found significant on all stages of crop except 30 DAS. The treatment combination of GW 322 with CCC @ 1500 ppm was recorded lowest plant height which was at par with the combination of GW 322 with ethephon @ 30 ppm over all other combination. Growth retardant induce reduction in stem elongation in wheat, which is attributes to either reduction in gibberellic acid synthesis or increase in ethylene synthesis (Gianfugna, 1995) and (Rajala, 2004).

The data pertaining to plant dry weight (Table 2) indicated that plant dry weight (g m^{-2}) at various growth stages increased progressively from vegetative up to harvest stage. The rate of increase in plant dry weight was highest between 30 to 60 DAS. Among the varieties, MP 1202 accumulated significantly higher dry weight 1026.30 and 1217.84 g m^{-2} at 90 and at maturity than over rest of the variety, respectively. The dry matter accumulation increased significantly with the plant growth regulators at all crop growth stages. Maximum significantly dry matter accumulation was recorded with cycocel @ 1500 ppm (987.87 and 1154.17 g m^{-2}) at 90 DAS and harvest which was statistically at par with ethephon 30 ppm but significantly higher over other treatments at all the crop growth stages except 30 DAS. At maturity, the dry matter accumulation in cycocel @ 1500 ppm was 6.75 % higher over control, since decreasing plant height is one of the ways of increasing the stem diameter and number of tillers and more production of dry matter (Miranzadeh *et al.*,2011).The interaction among different crop growth stage between wheat variety and plant growth regulators was found significant in the treatment combination of MP 1202 with CCC @ 1500 ppm and at par with ethephon @ 30 ppm at 60,90 DAS and harvest except 30 DAS.

Data from Table 3 revealed that LAI increased with the advancement of crop age and reaching peak at 60 DAS and it decreased thereafter at 90 DAS because of leaf senescence and tiller mortality at later growth stages. The LAI was significantly higher with the variety MP 1202 (2.98 and 2.66 at 60 DAS and 90 DAS) as compared to GW 322 (2.70 and 2.38). The plant growth regulators also had significant effect on LAI at 60 and 90 DAS. The maximum LAI of 3.05 and 2.63 were recorded in the treatment cycocel @ 1500 ppm at 60 and 90 DAS which was statistically at par with ethephon 30 ppm (2.97 and 2.54) whereas, minimum LAI was recorded with control at both the stages. Significant difference in interaction between wheat variety and plant growth regulators was recorded at 60 and 90 DAS crop growth stages with the treatment combination of MP 1202 with CCC @ 1500 ppm and at par with ethephon @ 30 ppm over remaining combination. The decrease in plant height resulted in excess of photo assimilates for growth of alternative sink i.e. increase in leaf area which will ultimately increase LAI. The results of present study are in conformation with the results of Miranzadeh *et al.* (2011) and Pirasteh Anosheh *et al.* (2012).

The maximum increase in number of tillers was observed from 30 to 60 DAS and 90 DAS thereafter, they decrease marginally up to at harvest. Significantly higher number of tillers m^{-2} (Table 4) were recorded with MP 1202 (579.08, 622.23, 611.65) as compared to GW 322 (527.83, 582.99, 577.10) and over rest of the variety at 60, 90 and at harvest, respectively. Number of tillers were significantly influenced by the application of different level of plant growth regulators. Maximum number of tillers were significantly recorded in the cycocel @ 1500 ppm treatment (515.38, 567.20, 553.51) which remained statistically at par with ethephon @ 30 ppm (502.98, 551.44, 537.51) at 60,90 and harvest but significantly higher over all other treatments at all the stages except at 30 DAS. MP 1202 with CCC @ 1500 ppm treatment combination was found significant over rest of the combination. Rajala (2004) hypothesized that PGRs induced inhibition of shoot elongation and provided excess photo-assimilates for growth of alternative sink i.e. for growth of tiller.

Yield and yield components

The grain yield of wheat variety as influenced by different plant growth regulators is given in Table 5. Variety MP 1202 recorded significantly higher grain yield (51.61 q ha^{-1}) than GW 322 (49.03 q ha^{-1}) and other rest of the variety. The grain yield was recorded 5.65% higher in MP 1202 variety over the GW 322 and remaining of the variety. Variation in grain yield of wheat variety was also reported by (Chakrawarty and Kushwaha, 2007). Among plant growth regulators, grain yield increases significantly with the application of cycocel @ 1500 ppm (49.99 q ha^{-1}) which was at par with ethephon @ 30 ppm (48.64 q ha^{-1}) as compared to all other treatments. The grain yield under application of cycocel @ 1500 ppm was 17.30 % higher over the other treatments, respectively. Higher grain yield was attributed to its reduction in plant height at tillering which lead to higher tiller survival and enhances fertile tillers, which resulted in greater yield in wheat. Results were recorded by (Dastan *et al.*, 2011) and (Bahrami *et al.*, 2014). Variety MP 1202 was recorded maximum straw and biological yield (72.00 and 123.79 q ha^{-1}) over other variety and which was followed by GW 322. The maximum straw and biological yield were recorded with the application of cycocel @ 1500 ppm (73.12 and 123.11 q ha^{-1}) followed by Ethephon @ 30 ppm (71.28 and 120.15 q ha^{-1}), but it was significantly higher over the other treatments. Significant interaction difference was found between wheat variety and plant growth regulators on yield and yield component which was higher in the treatment combination of MP 1202 with CCC @ 1500 ppm having at par with MP 1202 with ethephon @ 30 ppm. Cycocel and ethephon causes reduction in plant height, thereby provides excess photo-assimilates for increasing stem girth, leaf area, total number of tillers etc. These findings are in substantiate with the results reported by Bahrami *et al.* (2014) and Rajala and Peltonen-Sainio (2001). The variety MP 1202 recorded higher value of harvest index (41.86) followed by variety GW 322 (41.06). The plant growth regulators did not show any significant effect on the harvest index. Maximum harvest index was observed under cycocel @ 1500 ppm (40.79) followed by ethephon @ 30 ppm (40.60).

Conclusion

On the basis of the results, it can be concluded that variety MP 1202 performed better in terms of grain yield followed by GW 322 than all other variety. Among plant growth regulators, cycocel @ 1500 ppm followed by ethephon @ 30 ppm exhibited better growth attributes and grain yield as compared to other level of plant growth regulators.

Table 1: Plant height as influenced by wheat variety and plant growth regulators

Plant height (cm)				
Treatment	**30 DAS**	**60 DAS**	**90 DAS**	**At harvest**
Main plot-Variety				
GW 322	34.37	57.25	85.22	89.50
Sujata	34.51	76.77	105.71	109.91
C 306	34.50	71.88	101.20	105.39
MP 1202	34.39	63.84	89.30	92.35
SEm±	0.25	0.89	0.98	0.26
CD (p=0.05)	NS	3.12	3.46	0.92
Sub plot-Plant growth regulators				
Control	34.45	70.97	102.75	105.57
CCC @ 1000 PPM	34.45	68.88	93.55	97.54
CCC @ 1500 PPM	34.20	64.38	91.38	95.92
Ethephon @ 10 PPM	34.83	67.37	96.03	100.23
Ethephon @ 30 PPM	34.27	65.57	93.08	97.19
SEm±	0.41	0.45	0.70	0.44
CD (p=0.05)	NS	1.30	2.01	1.28

Table 1a: Interaction between wheat variety and plant growth regulators of plant height

Plant Height (cm)					
Treatment	**60 DAS**				
	GW 322	**Sujata**	**C 306**	**MP 1202**	**Mean**
Control	58.13	78.74	76.26	70.77	**70.97**
CCC @ 1000 PPM	59.66	77.94	74.71	63.21	**68.88**
CCC @ 1500 PPM	54.22	74.77	67.96	60.58	**64.38**
Ethephon @ 10 PPM	58.48	76.75	71.37	62.87	**67.37**
Ethephon @ 30 PPM	55.77	75.63	69.11	61.79	**65.57**
Mean	**57.25**	**76.77**	**71.88**	**63.84**	
SEm±	0.90				
CD (p=0.05)	2.61				
Treatment	**90 DAS**				
	GW 322	**Sujata**	**C 306**	**MP 1202**	**Mean**
Control	89.55	111.29	110.29	99.89	**102.75**
CCC @ 1000 PPM	86.22	103.62	98.12	88.91	**94.22**
CCC @ 1500 PPM	82.60	103.03	96.78	83.14	**91.38**
Ethephon @ 10 PPM	85.78	105.87	101.80	90.67	**96.03**
Ethephon @ 30 PPM	84.12	104.75	99.02	85.15	**93.26**
Mean	**85.65**	**105.71**	**101.20**	**89.55**	
SEm±	1.39				
CD (p=0.05)	2.07				

Treatment	At harvest				
	GW 322	**Sujata**	**C 306**	**MP 1202**	**Mean**
Control	95.39	116.42	115.79	97.54	**106.28**
CCC @ 1000 PPM	87.77	107.82	102.32	92.27	**97.54**
CCC @ 1500 PPM	86.80	107.23	100.98	87.47	**95.62**
Ethephon @ 10 PPM	89.98	110.07	106.00	94.87	**100.23**
Ethephon @ 30 PPM	88.89	108.95	103.22	89.09	**97.54**
Mean	**89.76**	**110.10**	**105.66**	**92.25**	**99.44**
SEm±	0.86				
CD (p=0.05)	2.49				

Table 2: Plant dry weight (g m^{-2}) as influenced by wheat variety and plant growth regulators

Treatments	**30 DAS**	**60 DAS**	**90 DAS**	**At harvest**
Main plot-Variety				
GW 322	92.01	475.38	983.23	1108.73
Sujata	89.36	451.16	866.73	1016.54
C 306	89.47	458.36	906.23	1090.14
MP 1202	93.70	501.78	1026.30	1217.84
SEm±	3.32	2.29	14.54	11.79
CD (p=0.05)	NS	8.06	51.25	41.58
Sub plot-Plant growth regulators				
Control	89.90	457.04	900.41	1081.42
CCC @ 1000 PPM	90.31	460.32	932.42	1084.73
CCC @ 1500 PPM	95.08	494.88	987.87	1154.17
Ethephon @ 10 PPM	88.81	464.08	932.39	1088.73
Ethephon @ 30 PPM	91.56	482.04	975.02	1132.51
SEm±	2.50	3.13	11.04	11.01
CD (p=0.05)	NS	9.06	31.93	31.85

Table 2a: Interaction between wheat variety and Plant Growth Regulators on plant dry weight (g/m^2)

Treatment	60 DAS				
	GW 322	**Sujata**	**C 306**	**MP 1202**	**Mean**
Control	464.09	439.87	448.06	476.13	**457.04**
CCC @ 1000 PPM	466.87	442.91	450.83	480.65	**460.32**
CCC @ 1500 PPM	497.80	466.13	474.46	541.13	**494.88**
Ethephon @ 10 PPM	470.35	447.80	453.32	484.84	**464.08**
Ethephon @ 30 PPM	477.80	459.09	465.15	526.13	**482.04**
Mean	**475.38**	**451.16**	**458.36**	**501.78**	
SEm±	6.26				
CD (p=0.05)	18.11				
Treatment	**90 DAS**				
	GW 322	**Sujata**	**C 306**	**MP 1202**	**Mean**
Control	914.08	857.42	901.83	928.33	**900.41**
CCC @ 1000 PPM	953.75	847.75	909.75	1018.42	**932.42**
CCC @ 1500 PPM	1028.33	889.08	915.08	1121.67	**988.54**
Ethephon @ 10 PPM	998.33	849.08	909.69	1004.42	**940.38**
Ethephon @ 30 PPM	1021.67	890.33	911.72	1058.67	**970.59**
Mean	**983.23**	**866.73**	**909.61**	**1026.30**	
SEm±	21.42				
CD (p=0.05)	61.99				
Treatment	**At harvest**				
	GW 322	**Sujata**	**C 306**	**MP 1202**	**Mean**
Control	1098.48	1008.48	1074.48	1144.21	**1081.42**
CCC @ 1000 PPM	1101.48	1005.48	1076.48	1155.48	**1084.73**
CCC @ 1500 PPM	1123.48	1035.77	1115.77	1341.68	**1154.17**
Ethephon @ 10 PPM	1105.48	1009.48	1080.48	1159.48	**1088.73**
Ethephon @ 30 PPM	1114.73	1023.48	1103.48	1288.35	**1132.51**
Mean	**1108.73**	**1016.54**	**1090.14**	**1217.84**	
SEm±	22.01				
CD (p=0.05)	63.69				

Table 3: Leaf area index as influenced by wheat variety and plant growth regulators

LAI			
Treatment	**30DAS**	**60DAS**	**90DAS**
Main plot-Variety			
GW 322	1.19	2.70	2.38
Sujata	1.13	2.57	2.16
C 306	1.13	2.47	2.04
MP 1202	1.43	2.98	2.66
SEm±	0.06	0.04	0.03
CD at 5%	NS	0.14	0.10
Sub plot - Plant growth regulators			
Control	1.21	2.30	1.97
CCC @ 1000 PPM	1.11	2.50	2.17
CCC @ 1500 PPM	1.34	3.05	2.63
Ethephon @ 10 PPM	1.15	2.58	2.22
Ethephon @ 30 PPM	1.29	2.97	2.54
SEm±	0.06	0.04	0.03
CD at 5%	NS	0.13	0.09

Table 3a: Interaction between wheat variety and plant growth regulators of leaf area index

Treatment	60 DAS					90 DAS				
	GW 322	Sujata	C 306	MP 1202	Mean	GW 322	Sujata	C 306	MP 1202	Mean
Control	2.29	2.28	2.20	2.43	2.30	2.02	1.94	1.86	2.06	1.97
CCC @ 1000 PPM	2.44	2.44	2.40	2.70	2.50	2.17	2.11	2.05	2.37	2.17
CCC @ 1500 PPM	3.00	2.89	2.75	3.56	3.05	2.77	2.33	2.16	3.27	2.63
Ethephon @ 10 PPM	2.54	2.49	2.46	2.81	2.58	2.21	2.15	2.05	2.48	2.22
Ethephon @ 30 PPM	3.20	2.76	2.52	3.40	2.97	2.73	2.28	2.06	3.11	2.54
Mean	**2.70**	**2.57**	**2.47**	**2.98**		**2.38**	**2.16**	**2.04**	**2.66**	
Interaction										
SEm±	0.09					0.06				
CD (p=0.05)	0.25					0.18				

Table 4: Number of tillers as influenced by wheat variety and plant growth regulators

Number of Tillers (m^{-2})				
Treatment	**30 DAS**	**60 DAS**	**90 DAS**	**At harvest**
Main plot-Variety				
GW 322	293.72	527.83	582.99	577.10
Sujata	297.62	408.63	445.90	422.42
C 306	287.28	440.62	464.98	447.76
MP 1202	300.99	579.08	622.23	611.65
SEm±	9.98	5.17	3.63	5.18
CD (p=0.05)	NS	18.23	12.79	18.25
Sub plot-Plant growth regulators				
Control	280.17	465.65	494.68	460.50
CCC @ 1000 PPM	299.05	484.67	517.78	512.33
CCC @ 1500 PPM	296.83	515.38	567.20	553.51
Ethephon @ 10 PPM	296.39	476.51	514.02	509.80
Ethephon @ 30 PPM	302.08	502.98	551.44	537.51
SEm±	9.48	5.65	5.81	5.87
CD (p=0.05)	NS	16.35	16.81	16.98

Table 4a: Interaction between wheat variety and plant growth regulators on number of tillers

Number of tillers (m^{-2})					
Treatment	**60 DAS**				
	GW 322	**Sujata**	**C 306**	**MP 1202**	**Mean**
Control	521.62	359.18	405.75	576.05	465.65
CCC @ 1000 PPM	530.05	388.15	446.08	574.40	484.67
CCC @ 1500 PPM	535.45	475.42	455.98	594.68	515.38
Ethephon @ 10 PPM	517.22	387.05	442.42	559.35	476.51
Ethephon @ 30 PPM	534.82	433.33	452.88	590.90	502.98
Mean	**527.83**	**408.63**	**440.62**	**579.08**	
SEm±	11.30				
CD (p=0.05)	32.70				
	90 DAS				
Treatment	**GW 322**	**Sujata**	**C 306**	**MP 1202**	**Mean**
Control	559.98	420.55	427.83	570.35	494.68
CCC @ 1000 PPM	569.07	451.73	469.88	580.43	517.78
CCC @ 1500 PPM	613.21	457.97	482.63	715.00	567.20
Ethephon @ 10 PPM	565.22	446.05	465.30	579.52	514.02
Ethephon @ 30 PPM	607.46	453.20	479.23	665.85	551.44
Mean	**582.99**	**445.90**	**464.98**	**622.23**	
SEm±	11.62				
CD (p=0.05)	33.62				
	At harvest				
Treatment	**GW 322**	**Sujata**	**C 306**	**MP 1202**	**Mean**
Control	508.82	393.43	403.33	536.43	460.50
CCC @ 1000 PPM	569.25	421.48	455.22	603.35	512.33
CCC @ 1500 PPM	641.67	439.45	468.51	664.40	553.51
Ethephon @ 10 PPM	562.10	421.30	454.67	601.15	509.80
Ethephon @ 30 PPM	603.65	436.43	457.05	652.92	537.51
Mean	**577.10**	**422.42**	**447.76**	**611.65**	
SEm±	11.74				
CD (p=0.05)	33.96				

Table 5: Grain yield, straw yield and harvest index as influenced by wheat variety and plant growth regulators

Treatment	**Grain yield (q ha^{-1})**	**Straw yield (q ha^{-1})**	**Biological yield (q ha^{-1})**	**Harvest Index**
GW 322	49.03	70.55	119.57	41.06
Sujata	37.08	56.20	93.28	39.78
C 306	39.43	59.30	98.73	40.14
MP 1202	51.61	72.00	123.79	41.86
Mean	**44.29**	**64.51**	**108.84**	**40.71**
SEm ±	0.44	0.75	1.21	
CD (p=0.05)	1.55	2.66	4.27	
Control	37.50	53.30	90.80	41.12
CCC @ 1000 PPM	41.43	60.63	102.06	40.50
CCC @ 1500 PPM	49.99	73.12	123.11	40.79
Ethephon @ 10 PPM	43.89	64.22	108.11	40.52
Ethephon @ 30 PPM	48.64	71.28	120.15	40.60
Mean	**44.29**	**64.51**	**108.84**	**40.71**
SEm±	0.45	0.63	1.04	
CD (p=0.05)	1.32	1.83	3.02	

Table 5a: Interaction between wheat variety and plant growth regulators of yield and yield component

Treatment	Grain yield (q ha^{-1})					Straw yield (q ha^{-1})				
	GW-322	Sujata	C-306	MP-1202	**Mean**	GW-322	Sujata	C-306	MP-1202	**Mean**
Control	40.30	32.69	35.92	41.08	**37.50**	55.74	49.55	52.31	55.60	**53.30**
CCC @ 1000 PPM	44.55	34.49	37.38	49.30	**41.43**	64.59	52.30	56.60	69.02	**60.63**
CCC @ 1500 PPM	56.42	41.70	43.28	58.55	**49.99**	81.80	63.17	65.54	81.97	**73.12**
Ethephon @ 10 PPM	49.07	35.65	39.50	51.35	**43.89**	71.15	54.04	59.81	71.89	**64.22**
Ethephon @ 30 PPM	54.79	40.89	41.09	57.79	**48.64**	79.45	61.93	62.24	81.52	**71.28**
Mean	**49.03**	**37.08**	**39.43**	**51.61**		**70.55**	**56.20**	**59.30**	**72.00**	
Interaction										
SEm±	0.91					1.26				
CD (p=0.05)	2.63					3.66				
Treatment	**Biological yield (q ha^{-1})**					**Harvest Index**				
	GW-322	Sujata	C-306	MP-1202	**Mean**	GW-322	Sujata	C-306	MP-1202	**Mean**
Control	96.04	82.25	88.22	96.68	**90.80**	41.77	39.76	40.73	42.21	**41.12**
CCC @ 1000 PPM	109.14	86.78	93.99	118.32	**102.06**	40.82	39.76	39.76	41.67	**40.50**
CCC @ 1500 PPM	138.22	104.86	108.82	140.53	**123.11**	40.88	39.84	40.34	42.11	**40.79**
Ethephon @ 10 PPM	120.21	89.68	99.30	123.23	**108.11**	40.82	39.76	39.84	41.67	**40.52**
Ethephon @ 30 PPM	134.24	102.82	103.33	140.19	**120.15**	41.01	39.76	40.01	41.63	**40.60**
Mean	**119.57**	**93.28**	**98.73**	**123.79**		**41.06**	**39.78**	**40.14**	**41.86**	
Interaction										
SEm±	2.09					0.44				
CD (p=0.05)	6.04					1.27				

References

Agricultural statistics at a glance. (2022). Source: E&S Division, DA&FW, E&S Division, DA&FW.pp.30-31

Breiman, A. and Graur, D. (2008). Prediction of wheat production using artificial natural networks and investigating indirect factors affecting it. *Journal of Agriculture Science and Technology*. 15: 791-803.

Bahrami K., Anosheh H Pirasteh, Emam Y. (2014). Yield and yield Components responses of barley cultivars to foliar application of cycocel. *Journal of Crop Production and Processing*. **12**: 27-36.

Chakrawarty, V.K., Kushwaha, K.P. (2007). Performance of barley (Hordeum vulgare L.) varieties under sowing dates and nitrogen levels in Bundelkhand. *Progressive Research*. **2**:163-64.

Dastan, S., Mobasser, H.R., Ghanbari-Malidarreh, A., Arab, R., Ghorbannia, E., Rahimi, R. (2011). Effects of sowing dates and Cycocel application on morphological traits, agronomical indices and grain yield in barley cultivars. *World Applied Sciences Journal*, **14**(11): 1717-1723.

Gianfagna, T. (1995). Natural and synthetic growth regulators and their use in horticultural and agronomic crops. In Davies P. (Ed.). Plant hormones: Physiology, Biochemistry and Molecular Biology. Dordrecht: *Kluwer Academic Publishers*.751-774.

Hilli, J.S., Vyakarnahal, B.S., Biradar D.P. and Hunje, R. (2010). Effect of growth regulators and stages of spray on growth, fruit set and seed yield of ridge gourd (*Luffa acutangula* L. Roxb). *Karnataka J. Agric. Sci*., **23**(2), 239–242.

Miranzadeh, H., Emam, Y., Seyyed, H. and Zare, S. (2011). Productivity and radiation use efficiency of four dryland wheat cultivars under different levels of nitrogen and chlormequat chloride. *Journal of Agriculture Science and Technology*, **13**: 339-351.

Pirasteh Anosheh, H., Emam, Y., Ashraf, M. and Foolad, M.R. (2012). Exogenous application of salicylic acid and chlormequat chloride alleviates negative effects of drought stress in wheat. *Advanced Studies in Biology*, **11**: 501-520.

Pirasteh Anosheh, H., Emam Y. and Asharaf, M. (2014). Impact of Cycocel on seed germination and growth in some commercial crops under osmotic stress conditions.*Archives of Agronomy and Soil Science*, **60**, 1277-1289.

Rajala, A. and Peltonen-Sainio, P. (2001). Plant growth regulator effects on spring cereal root and shoot growth. *Agronomy Journal*, **93**, 936-943.

Rajala, A. (2004). Plant growth regulators to manipulate oat stands. *Agricultural and Food Science*, **13**, 186-197.

Rajkumara, S. (2008). Lodging in cereals-A Review. *Agricultural Review*. **29**(1), 55-60.

Sheoran, O.P.D., Tonk, S., Kaushik, L.S., Hasija, R.C., Pannu, R.S. (1998). Statistical Software Package for Agricultural Research Workers. *Recent Advances in information theory, Statistics & Computer Applications by D. S. Hooda & R.C. Hasija, Department of Mathematics Statistics, CCS HAU, Hisar*. 139-143.

Urwiller, M.J. and Stuttle, C. A. (1986). Influence of ethaphon on soybean reproductive development. *Crop Science*. **26**: 976- 979.

Zagonel, J. and Fernandes, K. (2007). Doses de nitrogênio e densidades de plantas com e sem um reguladorde crescimento afetando o trigo, cultivar OR 1. Ciência Rural,*Santa Maria*., **32**(1): 25-29.