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Impact of Mannitol and Nano Urea to Supress the effect of Terminal Heat Stress on Wheat (*Triticum aestivum* L.)

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Abstract

The current study, "Effect of Mannitol and Nano urea to mitigate the effect of terminal heat stress on wheat (*Triticum aestivum* L.)," was conducted during the Rabi season of 2022-2023 and 2023-2024 at the student instructional farm (SIF) of Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya-224229 (U.P.)." The experiment was conducted using the wheat variety HD 2967, three replications, seven treatments, and a split plot design. The treatment consisted of foliar spraying 25 ppm of mannitol, 50 ppm of nano urea, and 100 ppm of each at 30 DAS. Distilled water was sprayed as a control. Wheat growth, biochemistry, yield, and yield qualities have all been examined in relation to the observations. At 60, 90, and maturity stages for both timely (15 November) and late (15 December) sowing, observations were made. On the other hand, yield and yield characteristics were measured during crop harvest. Foliar spray of mannitol and nano urea were performed well at 60, 90 DAS and at maturity parameters. Foliar application of nano urea with 25 ppm was recorded superior on germination (%), Number of tiller plant^{-1} (cm), dry biomass plant^{-1} (g), Total chlorophyll content in leaves (Arnon method), Membrane injury index (%), Total soluble sugar(mg g^{-1} fresh weight min^{-1}), Starch content (mg g^{-1} dry weight) However, yield and yield attributes viz length of spike, number of tillers plant^{-1}, number of grains spike^{-1}, grain yield plant^{-1} It is concluded from the result that foliar spray of nano urea 25 ppm was found most effective to increasing all characters and yield parameters of wheat.

Keywords: Wheat growth, nano urea, terminal heat stress, mannitol, foliar spray

1. Introduction

Wheat (*Triticum aestivum* L.) is the most important cereal crop. Wheat is classified as belonging to the genus Triticum within the Poaceae family. It is a long-day, annual plant that spreads by itself. Among all the crops grown worldwide, wheat is the most significant food cultivar. For around one third of the world's population, it is a staple food. 21.8% of the total area planted to food grains is made up of wheat crops. Roughly 36 percent of the global population gets its calories exclusively from wheat. For the approximately 4.5 billion people on the planet, it meets their needs for protein (10-12%) and calories (21%). The majority of them are from underdeveloped nations. 2021 saw the cultivation of wheat on 215.9 million hectares worldwide, yielding an output of 765.8 million tons at an average yield of 35.4 qha-1. India produces 109.52 mt and has a productivity of 34.64 qha-1 on an area of around 31.61 mha. Uttar Pradesh's productivity is 32.42 qha-1, its production is 31.16 mt, and its area is around 9.85 mha. Uttar Pradesh leads the nation in both area (32.89%) and wheat output (31.88%) (Agricultural Statistics at a Glance 2021). Hyperthermal circumstances have a significant impact on wheat output and other yield-related characteristics (Gupta *et al*., 2013). According to research, the ideal temperatures for anthesis and grain filling are 23 °C and 21.3 °C, respectively; crops exposed to temperatures higher than these result in lower yields (Farooq *et al*., 2011). In wheat, 20 to 30°C is the ideal temperature for photosynthesis, and any temperature above that quickly reduces the rate of photosynthesis (Narayanan, 2018). The thylakoid membrane and PS-II are the components of the heat-labile cell. Chlorophyll loss results from heat-induced thylakoid destruction (Ni *et al*., 2018). In India as well as many other cereal-growing regions of the world, high temperatures are a key factor in crop yield loss. High temperatures dehydrate plant tissue, which stops plants from growing and developing. Heat stress increases the soil water content threshold *i.e.*, the amount of water that the plant can extract (Haworth *et al*., 2018). High temperature stress often favours accumulation of reactive oxygen species (ROS) such as hydrogen peroxide (H_2O_2), superoxide radical (O^{2-}), hydroxyl ion (OH^-) and oxygen (O^{-1}) in plant tissues (Lai and He, 2016). The reactive oxygen species generated due to stress in chloroplast, mitochondria and peroxisome can disrupt the normal metabolism through oxidative damage of proteins, lipids and nucleic acid leading to damage of cell structure (Qaseem *et al*., 2019). Osmoprotectants or compatible solutes are small molecules having low molecular weight, electrically neutral, highly soluble and non-toxic at molar concentrations (Ahn *et al*., 2011). They help plants to survive in extreme osmotic environment (Lang 2007). Plant stress tolerance has been widely reported to be improved with the exogenous application of mannitol. Mannitol, an important osmolyte, is normally synthesized in large amount in many plant species (Su *et al*., 1999 and Mitoi *et al*., 2009). Nano Urea (Liquid) contains nano scale nitrogen particles which have more surface area Nano urea prepared by nanotechnology contains nano scale particles of Nano Urea. One nano urea liquid particle is 30 nano meters in diameter, with 10,000 times higher surface area to volume size than normal granular urea (Deepika *et al.*, 2022). Average physical size of Nano Urea particles is in the range of 20 -50 nm. Nano Urea contains 4 % nitrogen by weight in its nano form. Nitrogen present in Nano Urea effectively meets the crop nitrogen requirement. It has better use efficiency than conventional urea.

2. Materials and Methods

During the *Rabi* season of 2022-23 & 2023-24, the inquiry was conducted at the Acharya Narendra Deva University of Agriculture and Technology's Student Instructional Farm, Narendra Nagar, Kumarganj, Ayodhya (U.P.). Kumarganj is located at 26.47° north latitude and 81.12° east longitude, at an elevation of 113 meters, in the gangetic alluvium of eastern Uttar Pradesh. The experimental site is located in the Indo-Gangatic plains, in a sub-tropical climate with scorching summers and freezing winters. The monsoon season, which runs from July to September, receives over 80% of the total rainfall, with only a few showers in the winter. The design is Split Plot Design (S.P.D.) with seven treatments, three replications and variety HD 2967. Concentrations of Mannitol (25, 50, 100 ppm) and nano urea (25, 50, 100 ppm) foliar spray along with untreated control. Osmoprotectant and nano urea was sprayed at 52 DAS. The significance of various treatments was judged by The Fisher method of analysis of variance was used to analyze data collected on various growth and yield parameters (Fisher and Yates 1949).

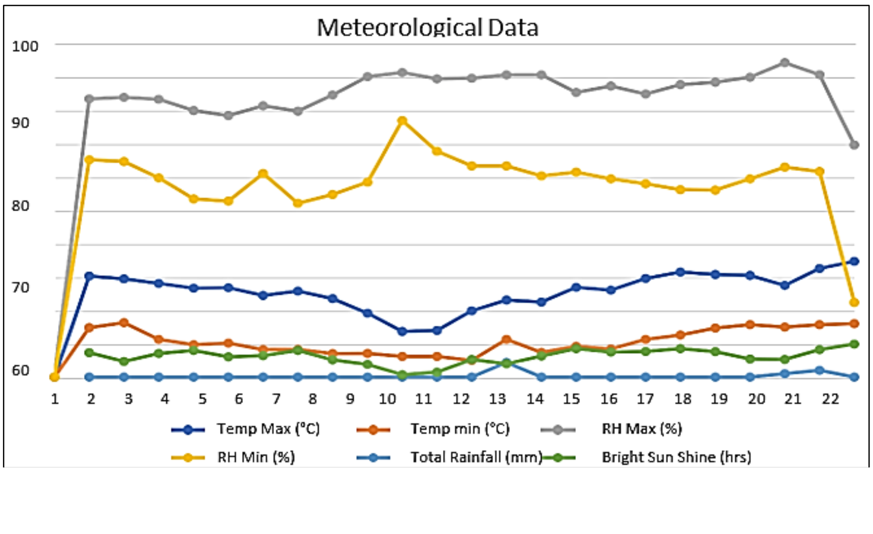

FIG 1:METEOROLOGICAL CHART DURING CROP PERIOD 2021-2022

3. Result and Discussion

3.1 Growth Parameters

3.1.1 Germination (%)

The findings showed that there were substantial differences in the percentage of wheat seeds that germinated under each treatment. Throughout the observation period, treatment T5 with nano urea 25 ppm had the greatest germination percentage (97.55%) for timely planting and (95.96%) for late sowing; in contrast, treatment T2 with mannitol 50 ppm had the lowest germination percentage (94.56%) for timely sowing and (92.52%) for late sowing. Every observation was made while priming wheat seedlings in a lab setting. Research has shown that applying zinc and nano urea can have a beneficial effect on wheat seed germination. According to Satish *et al*. (2022), seed priming has an impact on the comparable germination percentage of wheat seeds.

Treatments	Germination(%)	
	Timely sown	Late sown
T_1- Control	92.67	90.21
T_2- Mannitol (25ppm)	94.56	92.52
T_3 - Mannitol (50ppm)	96.88	95.62
T_4 - Mannitol (100ppm)	93.81	91.11
T_5 - Nano urea (25ppm)	97.55	95.96
T_6 - Nano urea (50ppm)	95.28	94.34
T_7 - Nano urea (100ppm)	94.52	92.71
S.Em ±	0.03	0.02
C.D. 5%	0.08	0.06

3.1.2 Number of Tiller Plant^{-1}

A table with information on plant height as it relates to different plant development nutrients at different growth phases has been created. When Nano Urea 25ppm was sprayed topically on timely planting (17.00 and 12.33), late sowing (15.33 and 11.00) at 60 DAS, 90 DAS, and maturity stage, respectively, and all other treatments combined, the number of tiller plants per treatment increased statistically significantly. At 60, 90 DAS, and maturity stages of observation above control, the minimal number of tiller plant-1 was discovered with foliar spray of Mannitol 25 ppm timely sowing (14.00 and 10.00), late sowing (60.52 and 87.38), respectively. The data conclude that the application of mannitol and nano urea significantly shows positive response to Number of tiller plant^{-1} of wheat, because of nitrogen and mannitol provide mechanical strength to the stem and increase their elongation. This result is similar to Zulkiffal, and Ahsan (2021), the height of wheat crop is influenced by nutrient applications and nano fertilizers.

Treatments	Number of tiller plant^{-1}			
	Timely sown		Late sown	
	60DAS	90DAS	60DAS	90DAS
T_1- Control	14.00	10.00	12.00	9.33
T_2- Manitol (25ppm)	14.67	10.33	12.67	9.67
T_3 - Mannitol (50ppm)	15.33	10.67	13.33	9.67
T_4 - Mannitol (100ppm)	16.29	11.00	14.23	10.33
T_5 - Nano urea (25ppm)	17.00	12.33	15.23	11.00
T_6 - Nano urea (50ppm)	16.67	11.67	15.00	10.67
T_7 - Nano urea (100ppm)	15.67	10.67	13.67	10.00
S.Em ±	0.17	0.16	0.13	0.12
C.D. 5%	0.50	0.45	0.37	0.35

3.1.3 Dry Biomass Plant-1 (g)

The table displays the observations made on dry weight plant-1 as impacted by different plant nutrition foliar sprays at various growth phases. At every stage of the crop, every foliar spray demonstrated a statistically significant increase in dry biomass over the control. The application of a 25ppm nano urea foliar spray at the 30, 90, and maturity stages resulted in the greatest increase in plant dry weight (27.54g, 37.05g, and 35.71g), as well as late sowing (27.37, 37.31, and 35.68 g). Conversely, at all observational phases compared to the control, the lowest plant dry biomass was seen with foliar spray of mannitol timely planting (25.32g, 34.55g, and 32.66g), late sowing (24.26, 33.73, and 31.62 g), respectively. According to the observed result, dry biomass of plant was increases continuously till 90 DAS but decreases about 8-10 % at maturity stage (Kumar *et al*., 2018). With the increase the dose of nitrogen the dry weight of plant will also increases. These similar results were also reported by Ahmed and Abdul (2022).

Treatments	**Dry biomass plant-1 (g)**					
	Timely sown			**Late sown**		
	60 DAS	**90 DAS**	**Maturity**	**60 DAS**	**90 DAS**	**Maturity**
T_1- Control	24.88	32.30	31.30	22.45	30.26	30.19
T_2- Manitol (25ppm)	25.32	34.55	32.66	24.26	33.73	31.62
T_3 - Mannitol (50ppm)	26.94	35.95	34.65	25.71	34.49	33.35
T_4 - Mannitol (100ppm)	26.21	35.25	33.74	25.98	35.85	33.92
T_5 - Nano urea (25ppm)	27.54	37.05	35.71	27.37	37.31	35.68
T_6 - Nano urea (50ppm)	25.71	34.71	33.87	26.53	35.22	32.11
T_7 - Nano urea (100ppm)	25.11	34.19	33.68	25.62	33.67	33.42
S.Em±	0.33	0.09	0.12	0.31	0.06	0.11
C.D. 5%	1.03	0.28	0.37	1.01	0.26	0.33

3.2.1 Total Chlorophyll Content in Leaves (Arnon Method)

The findings in the table, when critically analyzed, show that all foliar sprays of various plant nutrients raise the chlorophyll content of leaves by up to 60 and 90 DAS. When 25 ppm of nano urea was applied topically to leaves at timely planting (23.63 and 20.23) and late sowing (22.88 and 21.07) at 60 and 90 DAS, respectively, the greatest increase in chlorophyll was seen compared to the other treatments. But out of all the treatments over control, the least amount of chlorophyll was discovered with foliar spray of mannitol 25 ppm timely planting (19.17 and 15.25), late sowing (16.54 and 14.76), respectively. Chlorophyll content in leaf is positively influenced by the plant nutrients and nano fertilizers, due to increase in nitrogen content the plant chlorophyll content will also increases. The similar findings were also reported by Muhammad *et al*. (2022)

Treatments	**Total chlorophyll (Arnon method)**			
	Timely sown		**Late sown**	
	60 DAS	**90 DAS**	**60 DAS**	**90 DAS**
T_1- Control	16.20	10.73	14.73	10.28
T_2- Manitol (25ppm)	19.17	15.25	16.54	14.76
T_3 - Mannitol (50ppm)	20.64	16.10	19.32	15.93
T_4 - Mannitol (100ppm)	20.35	12.78	20.20	13.60
T_5 - Nano urea (25ppm)	23.63	20.23	22.88	21.07
T_6 - Nano urea (50ppm)	20.19	14.47	20.41	13.89
T_7 - Nano urea (100ppm)	19.82	13.40	18.56	12.15
S.Em±	0.70	1.15	0.67	1.12
C.D. 5%	2.17	3.55	2.03	3.49

3.2.2 Membrane Injury Index (%)

The findings in the Table, when critically analyzed, show that all foliar sprays of various plant nutrients raise the membrane damage index in leaves up to 60 and 90 DAS. When nano urea was applied topically at a rate of 25 ppm at timely planting (51.40 and 39.85), late sowing (58.21 and 44.15) at 60 and 90 DAS, respectively, the Membrane Injury Index increased to the greatest extent relative to the other treatments. Nonetheless, out of all the treatments over control, the minimal Membrane damage index was discovered with foliar spray of Mannitol 25 ppm timely sowing (52.13 and 39.84), late sowing (59.10 and 43.10), respectively. The similar findings were also reported by Anjum *et al*. (2011).

Treatments	Membrane injury index (%)			
	Timely sown		Late sown	
	60 DAS	90 DAS	60 DAS	90 DAS
T_1 - Control	51.20	40.32	60.36	41.33
T_2- Manitol (25ppm)	52.13	39.84	59.10	43.10
T_3 - Mannitol (50ppm)	52.83	40.10	59.85	42.33
T_4 - Mannitol (100ppm)	50.85	38.85	57.97	41.44
T_5 - Nano urea (25ppm)	51.40	39.58	58.21	44.15
T_6 - Nano urea (50ppm)	49.83	38.63	56.71	40.99
T_7 - Nano urea (100ppm)	47.08	38.23	54.08	39.64
S.Em±	0.19	0.15	0.17	0.14
C.D. 5%	0.55	0.43	0.50	0.40

3.2.3 Total Soluble Sugar (mg g^{-1} dry weight)

The findings in the Table, when critically analyzed, show that foliar spraying different plant nutrients increases total soluble sugar in wheat at different stages up to 60 and 90 DAS. The highest increase in total soluble sugar was seen with foliar spray of nano urea 25ppm at 60 and 90 DAS, respectively, for timely planting (64.66 and 93.52), late sowing (65.80 and 88.26), and over the remaining treatments. But among all the treatments compared to control, the lowest total soluble sugar was discovered with foliar spray of Mannitol 25 ppm timely planting (60.95 and 89.45), late sowing (59.04 and 83.19), respectively.The similar findings were also reported by Sharma *et al*. (2021).

Treatments	Total soluble sugar (mg g-1 dry weight)			
	Timely sown		Late sown	
	60 DAS	90 DAS	60 DAS	90 DAS
T_1 - Control	61.98	90.14	60.92	83.58
T_2 – Manitol (25ppm)	60.95	89.45	59.04	83.19
T_3 - Mannitol (50ppm)	62.48	90.96	61.40	84.56
T_4 - Mannitol (100ppm)	63.86	92.25	62.53	86.23
T_5 - Nano urea (25ppm)	64.66	93.52	65.80	88.26
T_6 - Nano urea (50ppm)	64.29	91.03	64.35	87.19
T_7 - Nano urea (100ppm)	62.78	92.82	61.80	85.67
S.Em±	0.80	1.08	0.75	1.09
C.D. 5%	2.28	2.42	2.13	3.12

3.2.4 Starch Content (mg g^{-1} dry weight)

The comprehensive examination of the data in the Table makes it abundantly evident that foliar spraying different plant nutrients increases the starch content of wheat at different concentrations by up to 60 and 90 DAS. When nano urea was applied topically at a rate of 25 ppm during timely planting (68.12 and 90.16) or late sowing (68.73 and 87.68) at 60 and 90 DAS, respectively, the highest increase in starch content was seen compared to the other treatments. Nevertheless, among all the treatments compared to control, the minimal starch content was discovered with foliar spray of Mannitol 25 ppm timely planting (63.65 and 85.15), late sowing (62.63 and 82.06) correspondingly. The similar findings were also reported by Karki *et al*. (2021).

Treatments	Starch content (mg g-1 fresh weight min-1)			
	Timely sown		Late sown	
	60 DAS	90 DAS	60 DAS	90 DAS

T_1 - Control	63.98	86.22	63.40	82.43
T_2- Manitol (25ppm)	63.65	85.15	62.63	82.06
T_3 - Mannitol (50ppm)	64.12	86.80	64.20	83.33
T_4 - Mannitol (100ppm)	66.05	88.65	66.38	85.63
T_5 - Nano urea (25ppm)	68.12	90.16	68.73	87.68
T_6 - Nano urea (50ppm)	64.29	89.92	67.17	87.43
T_7 - Nano urea (100ppm)	67.47	87.35	65.85	86.26
S.Em±	0.83	1.10	0.80	1.09
C.D. 5%	2.75	3.14	2.31	3.13

3.2.5 Length of spike (cm)

The data in the table makes it quite obvious that, when compared to the control, every foliar spray of various plant nutrients lengthens the spike. With foliar spray of nano urea 25ppm timely planting (11.47cm), late sowing (10.73cm) over the remaining treatments, the greatest length of spike was recorded. But among all the treatments, the lowest spike length was determined using foliar spray of mannitol 25ppm timely planting (10.33), late sowing (9.54), and control. Positive inflation of various plant nutrients has a direct impact on agricultural yield increase, including spike length. The similar result was reported by **Satish *et al.* (2022).**

3.2.6 Number of effective tillers plant^{-1}

The data in the table makes this clear. show unequivocally that, as compared to the control, the number of effective tillers plant^{-1} is increased by the foliar spraying of several plant nutrients. With timely planting (9.33), late sowing (8.73), and foliar spray of nano urea 25ppm over the remaining treatments, the greatest number of effective tillers plant^{-1} was reported. However, out of all the treatments over control, the smallest number of effective tillers plant^{-1} was reported with foliar spray of mannitol 25ppm timely sowing (8.33), late sowing (7.83). The number of tillers were also affected by plant nutrients but the greater number of tillers plants^{-1} was found in nano urea application because of accumulation nitrogen increase number of tillers. These results are accordance with **Arif *et al* (2017).**

3.2.7 Number of grains spike^{-1}

The data in the table makes this clear. show unequivocally that, when compared to the control, the number of grains spike^{-1} is greatly increased by the foliar spraying of various plant nutrients. With foliar spray of nano urea 25ppm timely planting (47.67), late sowing (45.83), and all other treatments combined, the greatest number of grains spike^{-1} was reported. However, among all the treatments over control, the smallest number of grains spike^{-1} was reported with foliar spray of mannitol 25ppm timely planting (37.67), late sowing (36.79). Number of grains spike^{-1} was also positively influenced by plant nutrients; it enhances the number of grains in spikes due to their biochemical activities. The similar data was reported by **Ahmed and Abdul (2022).**

Treatments	**Length of spike (cm)**		**Number ofeffective tillers plant-1**		**Number of grainsspike-1**	
	Timely sown	**Late sown**	**Timely sown**	**Late sown**	**Timely sown**	**Late sown**
T_1- Control	8.57	7.12	7.00	6.19	33.33	32.33
T_2- Manitol (25ppm)	10.33	9.54	8.33	7.83	37.67	36.79
T_3 - Mannitol (50ppm)	11.50	10.29	9.00	8.70	41.67	39.91
T_4 - Mannitol (100ppm)	10.93	9.04	8.33	6.99	41.00	40.64
T_5 - Nano urea (25ppm)	11.47	10.73	9.33	8.73	47.67	45.83
T_6 - Nano urea (50ppm)	10.57	8.65	8.66	7.89	43.67	42.74
T_7 - Nano urea (100ppm)	10.17	9.28	8.33	7.13	39.67	38.36
S.Em±	0.15	0.13	0.31	0.29	1.01	0.98
C.D. 5%	0.47	0.42	1.02	1.01	3.13	3.11

3.2.8 Grain yield plant^{-1} (g)

The results shown in Table make it abundantly evident that, as compared to the control, foliar spraying with various plant nutrients greatly improves grain yield plant^{-1}. With timely planting (9.23g) and late sowing (8.48g) in comparison to the other treatments, the greatest grain yield plant^{-1} was seen with foliar spray of nano urea 25ppm. Nevertheless, out of all the treatments over control, the minimum grain yield plant^{-1} was seen with foliar spray of mannitol 25 ppm timely planting (6.94g), late sowing (5.31g). The buildup of nitrogen and osmoprotectant had a favorable impact on grain yield plant^{-1}, resulting in a rise in the weight of the grains plant^{-1}.

These results are accordance with **Jat *at al.* (2013).**

3.2.9 Test weight (g)

Data collected on 1000 seed weight in each foliar spray are presented in Table. The foliar spray of different plant nutrients reveal that increment in seed weight over the control. The maximum seed weight was registered with foliar spray of nano urea 25ppm timely sowing (44.53g), late sowing (43.39g) over rest of the treatments. However, the minimum seed weight was registered with foliar spray of mannitol 25 ppm timely sowing (40.92g), late sowing (40.23g) over rest ofthe treatments including control. The weight of seed is also increased due to bio- chemical activities of osmoprotectant and nitrogen. The similar findings were also given by **Satish *et al.* (2022).**

Treatments	Grain yieldplant-1 (g)		Test weight (g)	
	Timely sown	Late sown	Timely sown	Late sown
T1 - Control	5.71	4.49	40.92	39.38
T2 - Manitol (25ppm)	6.94	5.31	41.72	40.23
T3 - Mannitol (50ppm)	8.73	7.82	43.93	42.94
T4 - Mannitol (100ppm)	7.79	6.99	43.07	43.15
T5 - Nano urea (25ppm)	9.23	8.48	44.53	43.39
T6 - Nano urea (50ppm)	8.30	7.73	41.13	40.02
T7 - Nano urea (100ppm)	8.08	7.94	42.43	41.74
S.Em±	0.14	0.12	0.56	0.48
C.D. 5%	0.44	0.40	NS	NS

3.2.10 Grain yield (q h-1)

Grain yield quintals per hectare have been presented in table. all the foliar spray of different plant nutrients significantly increases the grain yield q h^{-1} over the control. Significantly, the maximum grain yield q h^{-1} was recorded with foliar spray of nano urea 25ppm timely sowing (55.85q h^{-1}), late sowing (54.99 q h^{-1}) over rest of the treatments. However, the minimum grain yield q h^{-1} was recorded with foliar spray of mannitol 25 ppm timely sowing (50.97q h^{-1}), late sowing (49.63 q h^{-1}) among all the treatments over control. Due to increment in grain yield plant^{-1} thereby, increment in grain yield (q h^{-1}). The similar result was also found by **Partha *et al*. (2017).**

3.2.11 Harvest index (%)

The data presented in table. clearly indicate that non-significant variables were found due to foliar spray of plant nutrients. Maximum harvest index (41.88%) was observed with foliar treatment of nano urea 25ppm over the other treatment including control. Harvest index was also influenced by the foliar applications of plant nutrients. Nutrient-use efficiency refers to the ability of plants to transport and utilize nutrients effectively for growth and yield. Thereby they can allocate resources more efficiently towards grain production, leading to an increased harvest index. The similar findings were observed by **Mohd. Arif *et al.* (2019).**

Treatments	Grain yield(q h-1)		Harvest index (%)	
	Timely sown	Late sown	Timely sown	Late sown
T_1- Control	48.68	47.39	39.15	37.84
T_2- Manitol (25ppm)	50.97	49.63	39.25	38.57
T_3 - Mannitol (50ppm)	53.84	51.19	41.34	40.29
T_4 - Mannitol (100ppm)	52.51	52.08	39.95	38.05
T_5 - Nano urea (25ppm)	55.85	54.99	42.58	42.14
T_6 - Nano urea (50ppm)	54.66	53.26	41.55	40.82

T_7 - Nano urea (100ppm)	53.27	52.74	39.38	38.94
S.Em±	0.04	0.03	NS	NS
C.D. 5%	0.14	0.12	NS	NS

Conclusion

The results of the current study unequivocally show that mannitol and nano urea foliar spraying worked well at 60, 90 DAS, and maturity criteria. Foliar application of nano urea with 25 ppm was recorded superior on **Germination%,Number of tiller plant^{-1},(cm), dry biomass plant^{-1} (g), chlorophyll content in leaves (SPAD value), Membrane injury index(%), Total soluble sugar(mg g-1 dry weight), Starch content (mg g-1 dry weight)** However, yield and yield attributes viz length of spike, number of tillers plant^{-1}, number of grains spike^{-1}, grain yield plant^{-1}. The results indicate that the most successful method for enhancing all of the wheat's characteristics and yield metrics was to apply a foliar spray of 25 parts per million nanourea. Additional confirmation is required for the current finding.

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