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To study the response of salicylic acid on growth, physiological traits, yield and yield components of wheat varieties on timely and late sown conditions

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Abstract
The present investigation entitled "Effect of salicylic acid on growth, physio-chemical changes and yield of wheat (*Triticum aestivum* L.) under high temperature at anthesis" was conducted at Students Instructional Farm of the Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (U.P.) during r*abi* seasons of 2014-15 and 2015-16. The experiment was planned under RBD (Randomized Block Design) with three replications. The treatment consisted of two date of sowing *viz*;25th November and 25th December with two varieties NW-5054 and NW-2036 with ten salicylic acid treatment. Results indicated that growth attributes such as plant height, number of tillers per plant and dry weight per plant influenced with the date of sowing. When late sown variety was planted timely all the growth attributes showed drastic reduction with respect to late sowing (25th December).However, NW-5054 showed comparatively good performance in terms of growth attributes at timely sown (25th November). Performance of NW-5054 was very good as compared to NW-2036 due to delayed sowing on 25th December. Among SA treatments,T10(Seed soaking in (0.75mM) salicylic acid + Foliar spray of (0.75mM) salicylic acid at 30 DAS) resulted in highest increase in these traits while T9 (Foliar spray of (0.75mM) salicylic acid at 30 DAS)over control. Proline content in leaves increased with the age of the crop up to 90 DAS in both the date of sowing. The highest amount of proline content was recorded at 90 DAS in both the varieties under both the date of sowing. Date of sowing influenced the membrane injury index (MII). Both the varieties had higher MII at 60 DAS. SA treatment significantly decreased the MII at all the growth stages. The activity of antioxidant enzymes *viz;* catalase, superoxide dismutase and peroxide in leaves increased with the age of the crop up to 90 DAS under both the date of sowing in both the varieties.SA treatments increased the activities of catalase, superoxide dismutase and peroxide enzyme. However, maximum increase in the activity of these enzymes was observed with T10 (Seed soaking in (0.75mM) salicylic acid + Foliar spray of (0.75mM) salicylic acid at 30 DAS). Time of sowing decreased substantially almost in all the yield components measured *viz*; number of ear per plant, ear length, number of grains per plant, test weight, biological yield and harvest index which caused severe reduction in yield. Overall, T10 (Seed soaking in (0.75mM) salicylic acid + Foliar spray of (0.75mM) salicylic acid at 30 DAS) treatment showed best result and T2 Seed soaking in (0.25mM) salicylic acid gave least. All the salicylic acid treatments reduced the detrimental effect of heat stress on both the varieties by improving physiological traits which ultimately helped in obtaining higher yield.

Keywords: Growth, conditions, physiological traits, yield and yields components

Introduction
Wheat (*Triticum aestivum* L.) is the most important cereal crop belongs to family poaceae. It is staple diet for more than one third of the world population. Wheat crop occupies 21.8% of the total area under food grains. It constitutes the staple food for at least 43 countries including China, India, USA, France, Russia, Canada, Australia and a member of European countries. Wheat is an important crop of India. It is grown over 26 million hectares. Wheat production in 2016-17 is forecast at 93.5 million tonnes (Source: International Grains Council (IGC).India ranks second in area (12.5%) and production (12.05%) of wheat in the world which is next to China (Anonymous, 2013) [13]. India has about 29.25 mha area with the production of 85.93mt and productivity of 29.38 q/ha. The northern and western part of India has maximum area and production under wheat cultivation. In Uttar Pradesh, area, production and productivity are 9.67 mha, 33.97 mt and 31.13q/ha, respectively Uttar Pradesh ranks first in area (36.58% of India) and production (36.27% of India) of wheat in the country.

In India, wheat production has been stagnant around 70-72 million tonnes since 1999-2000, to meet the increasing demand of the growing population till 2020, it is estimated that around 9 million tonnes wheat grain production will be required. It is consumed in the form of chapattis, puris, suji or rawa. Wheat grain has relatively high content of niacin and thiamine that's why wheat proteins are especially important in human diet. Beside their significance in nutrition they are principally concerned in providing the "gluten" which provides spongy cellular texture of bread and baked product. Wheat straw is good source of feed for a large population of cattle in our country.

High temperature stress is a major cause of yield loss in cereal crops throughout many of the world's cereal growing areas, including India. Wheat plants are exposed to numerous biotic and abiotic stresses causing significant effect on the growth and cause changes in the normal physiological functions of the plants. The cultivation of wheat is limited by temperature at both ends of the cropping season and high temperature stress has an adverse effect on wheat productivity. The terminal heat stress was at anthesis and grain filling stages accelerate maturity and significantly reduce grain size, weight and yield (Kamal *et al.,* 2013) [8].

PGRs are extremely important agent and play an important role from germination up to senescence of the plant. Plant growth regulators (PGRs) can play an important role in increasing its yield by making the plants photo synthetically more effective (Sinha and Ghildyal, 1973) [25]. Use of growth regulators increased the rate of photosynthesis by increasing the chlorophyll content per unit area and the size of the mesophyll cells of leaves.

Salicylic acid (SA) is a phenolic compound involved in the regulation of growth and development of plants, and their responses to biotic and abiotic stress factors (Miura and Tada, 2014) [14]. Salicylic acid can also play a significant role in plant water relations (Barkosky and Einhelling, 1993) [4] under abiotic stress conditions. SA is involved in the regulation of important plant physiological processes such as photosynthesis, nitrogen metabolism, proline (Pro) metabolism, production of glycine betaine (GB), antioxidant defense system, and plant-water relations under stress conditions and thereby provides protection in plants against abiotic stresses (Khan *et al*., 2014) [10].

Exogenously sourced SA to stressed plants, either through seed soaking, adding to the nutrient solution, irrigating, or spraying induces major abiotic stress tolerance-mechanisms. Salicylic acid mediated improved plant tolerance to heat stress has also been reported (Khan *et al*., 2013) [11].

Material and Methods

The present investigation was conducted at Students Instructional Farm of the Narendra Deva University of Agriculture & Technology, Kumarganj, Faizabad (U.P) during *rabi* seasons of 2014-15 and 2015-16. The details of materials used and experimental procedures followed and techniques used along with conditions prevailing during crop period have been presented in this chapter. The site has sub-humid climate and falls in the Indogangetic plains having an alluvial soil and lies between latitude 26.47^0 North and at a longitude 82.12^0 East with an elevation of about 113 meters from sea level and is subjected to extremes of weather conditions. Thirty plants of same vigour were tagged in each plot for the study of growth attributes, physiological traits and yield as well as yield components. Five tagged plants were randomly uprooted from each plot with the help of khurpi at each date of observation (i.e. 30 DAS and 60 DAS).

A different concentration of salicylic acid was prepared in one liter of water dissolving required amount to prepare 0.25mM, 0.50mM and 0.75mM solution, respectively for seed soaking treatments. The seeds of both the wheat varieties were soaked separate flask in the solution of different concentration of salicylic acid for 10 hours. After that seeds were taken out from the solution and kept on blotting paper to remove water from seeds. The seeds were sown @ 100 kg ha^{-1} in row space 20 cm at average depth of 5 cm with the help of kudali. Nitrogen, phosphorus and potash were added at the rate of 120, 80 and 60 kg ha^{-1} through urea, DAP and murate of potash, respectively. Half of the nitrogen, total phosphorus and potash were added as basal dose before sowing of seeds. Remaining nitrogen was added in two equal split doses, one at tillering and other at the time of spike initiation. Solution of different concentrations of salicylic acid was prepared in desired volume of water dissolving required amount to prepare 0.25mM, 0.50mM and 0.75mM solution, respectively for foliar spraying. In order to improve the spray retention, a sticky agent, teepol, was mixed into the spray solution @ 0.5ml/litre. A spray volume of 500 liters per hectare was used to spray the crop. The spraying was done with the help of knapsack sprayer at 30 DAS.

The plant height was measured in cm from soil level to its tip at different crop growth stages. Number of tillers per plant under each treatment was recorded by counting tillers in five tagged plants at various stages of crop and average number of tillers per plant was calculated. The number of total ear bearing tillers of each treatment from five randomly selected plants were counted carefully and average was taken to get the number of ear bearing tillers. Ear length was measured in centimeters from the top (excluding awns) to be base of the ear. Length of 5 randomly selected ears from each treatment was measured and averaged to get length of single ear. The average weight of grains from randomly selected plants of each treatment was recorded as grain yield per plant.

The relative water content (RWC) was determined by the method described by (Turner 1981) Leaf discs were cut from the leaves, weighed and saturated by floating on distilled water in petridishes for four hours. The discs were surface dried and weighed. After that discs were kept in oven at 75 ± 5 ^{0}C for 24 hours. After drying, weight of dises was calculated with the help of electronic balance. RWC was calculated by the following formula.

$$\text{RWC}\ (\%) = \frac{\text{Fresh weight (g) - Dry weight(g)}}{\text{Saturated weight (g) - Dry weight (g)}} \text{ x } 100$$

The total chlorophyll content was estimated following the method of (Arnon 1949) and expressed as mg per g fresh weight.

Procedure

200 mg fresh leaves were homogenized in 10 ml of 80 % aqueous acetone and centrifuged at 4000 rpm for 20 minutes. The supernatant was collected and the residue was re-extracted with 10 ml of 80 % acetone and centrifuged again. Both the supernatants were combined and volume was made to 20 ml with 80% acetone. O.D. was measured at 645 nm and 663 nm on spectronic-20 using 80% acetone as blank. The amount of total chlorophyll was calculated as follows:

Total Chlorophyll.

$$=20.2 \times O.D.\ (645) + 8.02 \times O.D.\ (663) \times \frac{V}{1000 \times W}$$

Where,

V	=	Final volume
W	=	Weight of sample
OD	=	Optical density

Data recorded on various growth and yield attributes were subjected to statistical analysis by Fisher method of analysis of variance (Fisher and Yates 1949) [5]. The significance of various treatments was judged by comparing calculated, F' value with Fisher's, F' value at 5 percent level, incorporate in tables, were also calculated to compare the relative performance of various treatments by using the following formula:

$$SEm \pm = \sqrt{\frac{EMS}{N}}$$

Where,
EMS is mean sum of square of error
N = total number of experimental unit
Level of factors

$$CD = \sqrt{\frac{2EMS}{N}} \times t\,(5\%)$$

Where,
Value of't' from Fisher's table at error degree of freedom on 5% level of significance.

Results and Discussion

In general, total chlorophyll content in leaves increases up to 60 DAS under all sowing condition, afterward a significant decrease was observed (Table No. 3). Delayed sowing, significantly decreased total chlorophyll content at all the stages of observation with respect to normal sowing in both the varieties. Similar result was also obtained by (Shubhra *et al*., 2006) [22] who reported that late sowing decreased photosynthetic pigments compared to timely sowing condition. In support of these findings (Almeselmani *et al*., 2006) [1] also found significant reduction in chlorophyll content with age and also under late sowing at all the stages of plant growth. At 30 DAS seed soaking treatment significantly improved in total chlorophyll content with respect to control in both NW5054 and NW 2036. The application of salicylic acid (0.75 mM, 0.50mM and 0.25mM) as seed soaking as well as foliar spray and seed soaking + foliar spray significantly increased total chlorophyll content at 60 and 90 DAS of observations in both timely and late sown varieties (NW-5054 and NW-2036). Maximum total chlorophyll content was obtained in T_{10} followed by T_8 and T_7 compared with control in both the varieties. These results are in accordance with findings of (Jakhar and Sheokand 2015) [6], they reported that SA as a foliar spray may increase the chlorophyll content in treated plants as compared to un-treated plants.

In general, delayed sowing registered significant increase in relative water content in the leaf of wheat cultivars. High temperature at anthesis inhibit the biosynthesis of amino acid Valine and Isoleucine, which may be one of the reason for decrease in relative water content with different date of sowing in wheat have been also reported by (Panozzo *et al*., 2001) [19]. Data on relative water content (Table No. 2) at 30 DAS reveal that seed soaking treatment increased relative water content with respect to control in both NW5054 and NW 2036.The effect of higher dose of SA was more pronounced than lower dose. Salicylic acid (0.75 mM, 0.50mM and 0.25mM) as seed soaking and foliar spray and as well as seed soaking + foliar spray significantly increased relative water content at 60 and 90 DAS of observations in both timely and late sown varieties (NW-5054 and NW-2036). Maximum relative water content was obtained in T_{10} followed by T_8 and T_7compared to control in both the varieties. (Rao *et al*., 2012) [20] reported the effects of SA on relative water content of ajowan (*Carum copticum*) under stress.

The growth and yield of wheat crop is adversely affected by environmental stresses such as high temperature stress. High temperature at flowering and grain filling stage shortens the duration of grain filling period, resulting in early maturity, thus reducing the crop yield. High temperature between flag leaf stage and flowering reduces sink period, reducing the grain size. (Sharma and Tandon 1997) [21]. Growth attributes like plant height and number of tillers per plant increase with the increase of plant age. The investigation shows that sowing of late variety on normal sowing date decreased significantly growth attributes (plant height and number of tillers plant^{-1}) of wheat plant as compared with timely sown variety at normal date. However, reduction in growth attributes was recorded in case of timely sown variety under late sown condition at all the stages of observation. These reductions may be attributed to the relatively higher temperature prevailing during the critical stages of growth in late sowing plant. In addition, the reduction in the studied growth parameters as plant height, number of tillers/ plant of wheat plant in response to late sowing date of timely sown variety can be ascribed to the effect of high temperature on the membrane permeability and the transpiration rate.

The data presented in (Table No. 1 and 2), application of SA as seed soaking and foliar spray as well as their combination significantly caused significant increase in all plant growth measurements as compared with the control treatment at 30 and 60 DAS under both timely and late sown condition. But the effect of salicylic acid was more pronounced on NW-5054 sown under late sown condition. In general, the favorable effect of SA on overall growth of wheat might be on account of increased photosynthetic efficiency. In the present investigation, due to application of SA could be ascribed to enhanced plant height and number of tillers over control. Similar results were reported by (Nainwal *et al*., 2000) [18] which showed maximum reduction in growth attributes of late sown crop. This might be due to lowering of temperature which results in decrease in cell activity like cell division and expansion. (Karim *et al*., 2011) [9] noted that the application of 100, 200 and 400 ppm salicylic acid increased plant height and number of tillers/plant in wheat. Treatment with SA increased plant height in two different date of sowing. Similar findings related to increase in plant height was also reported by (Nagasubramaniam *et al*., 2007 [16, 17]) in baby corn.

Maximum grain yield was recorded from the crop sown on 25th November and significantly differed from crop sown on 25th December (Table No. 3). It might be concluded that the growth attributes are adversely affected by delayed sowing of wheat which leads to forced maturity because of high temperature prevailed during reproductive phase of the late sown crop. Due to that maximum grain yield was recorded in early sown wheat crop in comparison with late sown crop.

Variety NW-2036 showed better response in terms of number of ear per plant (Table No. 3), number of grains per plant (Table No. 3) and grain yield per plant per plant, however, NW-5054 showed reduction under late sown condition in all the traits associated with yield and yield components. Similar findings were also reported by (Bangarwa *et al*., 1996) [3] observed that both the yield attributes such as number of effective tillers and 1000-grain weight are highest under timely sowing as compared to late sowing conditions. The reason for this is that with increase in temperature there is reduction in the growth period which results in decrease in yield attributing characters, affecting finally the grain yield.

Similar to our results reduction in number of ear per plant and ear length has been also reported by (Singh *et al*., 2007) [23]. In this respect, (Singh *et al*., 2003) [24] reported that high temperature and desiccating winds during the month of April might have caused forced maturity of late sown wheat. Grain yield is the product of number of grains per plant and ear length hence reduction in all these components under late sowing accounted for greater decrease in grain yield. Delay in sowing after the optimum date showed decreasing trend in the yield of the crop. The crop sown on 25th November showed maximum number of effective tillers as compared to late sown one (Jat *et al*., 2013 and Mukherjee *et al*., 2012) [7, 15].

Almost all the SA treatments showed significant increase in all the yield and yield attributes. Overall T_{10} (0.75mM seed soaking + foliar spray) treatment showed best result followed by T_8 (0.75mM seed soaking). The positive increases in the yield and its components in response to SA are in agreement with those obtained by (Mandavia *et al*., 2006) [12] who applied SA on chick pea plants. These increments in the yield component due to SA treatments may be attributed to the increase in growth rate. In this respect, (Mathur and Vyas 2007) [13] reported that SA play a critical role in yield and its components like ear length, ear diameter and grain yield per plant of pearl millet was significantly increased by bio regulators applications.

Table 1: Effect of date of sowing and salicylic acid on plant height (cm) and number of tiller per plant at various stages of wheat varieties:

Treatments	Plant height (cm)								Number of tiller per plant							
	Timely sown				Late sown				Timely sown				Late sown			
	30 DAS		60 DAS		30 DAS		60 DAS		30 DAS		60 DAS		30 DAS		60 DAS	
	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2
T_1-Control	30.33	26.33	79.00	77.67	26.67	33.33	76.67	81.33	5.67	5.67	14.00	13.00	5.67	5.67	13.00	14.00
T_2-0.25mMS	31.64	27.81	79.88	79.10	27.19	33.74	77.14	81.96	6.33	5.67	14.67	13.67	5.67	6.33	13.67	14.67
T_3-0.25mMF	30.48	26.56	79.22	78.56	26.82	33.37	76.92	81.73	6.00	5.67	14.33	13.33	5.67	6.00	13.33	14.33
T_4-0.25mMS+F	32.89	28.63	81.88	80.44	30.63	34.92	78.44	83.14	7.24	6.67	15.67	14.33	6.67	7.24	14.33	15.67
T_5-0.50mMS	33.12	29.05	82.10	80.92	31.02	35.73	78.92	83.47	7.86	7.00	16.00	14.67	7.00	7.86	14.67	16.00
T_6-0.50mMF	30.87	27.10	80.33	79.83	27.61	34.17	77.69	82.26	6.33	6.33	15.00	14.00	6.33	6.33	14.00	15.00
T_7-0.50mMS+F	33.60	29.25	82.46	81.22	31.50	35.97	79.49	84.20	8.33	7.33	16.00	15.00	7.33	8.33	15.00	16.00
T_8-0.75mMS	35.20	29.91	82.56	81.76	33.35	36.49	79.90	84.78	8.66	7.67	16.00	15.33	7.67	8.66	15.33	16.00
T_9-0.75mMF	30.95	27.12	81.25	80.13	26.59	34.56	78.05	82.78	7.00	6.67	15.33	14.33	6.67	7.00	14.33	15.00
T_{10}-0.75mMS+F	35.87	30.03	83.90	82.23	34.47	37.23	80.63	85.52	9.33	8.00	16.33	15.67	8.00	9.33	15.67	16.33
	SEm±	CD at 5 %	SEm±	CD at 5 %	SEm±	CD at 5 %	SEm±	CD at 5 %	SEm±	CD at 5 %	SEm±	CD at 5 %	SEm±	CD at 5 %	SEm±	CD at 5 %
Variety (V)	0.57	1.61	0.68	1.92	0.61	1.66	0.72	1.94	0.037	0.105	0.175	0.502	0.035	0.101	0.130	0.371
Treatments (T)	0.66	4.03	0.79	4.81	0.69	4.01	0.83	4.85	0.082	0.234	0.392	1.122	0.079	0.226	0.290	0.830
V×T	1.15	3.21	1.37	3.83	1.21	3.22	1.42	3.86	0.116	0.331	0.555	1.587	0.111	0.319	0.410	1.173

Table 2: Effect of date of sowing and salicylic acid on relative water content (%) and total chlorophyll content (mg g^{-1} fresh wt.) at various stages of wheat varieties:

Treatments	Relative water content (%)								Total chlorophyll content (mg g^{-1} fresh wt.)							
	Timely sown				Late sown				Timely sown				Late sown			
	30 DAS		60 DAS		30 DAS		60 DAS		30 DAS		60 DAS		30 DAS		60 DAS	
	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2
T_1-Control	84.16	74.10	77.53	69.47	76.81	77.98	71.67	75.71	1.41	0.88	2.17	1.94	1.34	1.62	1.90	1.98
T_2-0.25mMS	84.77	75.33	80.26	71.74	77.93	79.03	72.37	78.23	1.66	0.93	2.23	1.99	1.40	1.70	1.96	2.05
T_3-0.25mMF	84.40	74.90	79.60	71.30	77.60	78.50	72.37	76.20	1.62	0.90	2.21	1.96	1.37	1.66	1.95	2.00
T_4-0.25mMS+F	85.88	76.85	81.92	72.80	79.16	81.47	72.88	81.27	1.91	1.10	2.33	2.08	1.51	1.80	2.01	2.10
T_5-0.50mMS	86.18	77.20	82.30	73.23	80.20	82.00	73.77	82.01	1.99	1.13	2.35	2.15	1.60	1.88	2.10	2.18
T_6-0.50mMF	85.08	75.78	80.33	71.84	77.98	79.63	72.50	79.26	1.70	0.98	2.25	2.00	1.42	1.75	1.98	2.09
T_7-0.50mMS+F	86.44	78.95	83.06	73.87	81.26	82.16	74.14	82.86	2.00	1.15	2.41	2.45	1.69	1.95	2.19	2.32
T_8-0.75mMS	86.96	79.80	84.73	74.67	82.31	82.93	75.28	83.41	2.08	1.19	2.87	2.66	1.85	2.10	2.45	2.85
T_9-0.75mMF	85.17	75.81	81.16	72.27	78.43	80.66	72.84	80.90	1.73	1.05	2.29	2.02	1.48	1.75	2.00	2.12
T_{10}-0.75mMS+F	87.63	80.71	85.46	75.25	83.53	83.47	76.37	85.74	2.15	1.25	3.05	2.78	2.00	2.26	2.75	3.08
	SEm±	CD at 5 %	SEm±	CD at 5 %	SEm±	CD at 5 %	SEm±	CD at 5 %	SEm±	CD at 5 %	SEm±	CD at 5 %	SEm±	CD at 5 %	SEm±	CD at 5 %
Variety (V)	0.55	2.31	0.90	3.62	0.57	2.33	0.88	3.60	0.024	0.069	0.040	0.114	0.022	0.064	0.035	0.101
Treatments (T)	0.74	2.99	0.93	3.73	0.76	3.01	0.91	3.71	0.054	0.154	0.089	0.255	0.050	0.143	0.079	0.227
V×T	1.00	4.01	1.57	6.28	1.03	4.03	1.55	6.25	0.076	0.218	0.126	0.360	0.071	0.203	0.112	0.321

Table 3: Effect of date of sowing and salicylic acid on ear length (cm), ear bearing tillers per plant, grain yield per (g) and straw yield per plant (g) of wheat varieties:

Treatments	Ear length (cm)				Ear bearing tillers per plant				Grain yield per plant (g)				Straw yield per plant (g)			
	Timely sown				Late sown				Timely sown				Late sown			
	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2
T_1-Control	8.81	8.62	8.54	8.18	10.00	7.33	8.33	8.33	13.54	10.61	12.65	12.75	13.80	13.86	10.68	12.74
T_2-0.25mMS	8.96	8.71	8.63	8.45	10.67	8.33	9.66	9.33	13.60	10.71	12.82	12.98	14.35	13.98	11.02	13.36
T_3-0.25mMF	8.92	8.61	8.54	8.27	10.33	7.83	9.08	8.67	13.56	10.66	12.70	12.82	13.91	13.92	10.72	13.25
T_4-0.25mMS+F	9.11	8.82	8.66	9.31	11.33	9.33	10.47	11.00	13.94	10.95	13.12	13.33	15.20	14.42	11.84	14.24
T_5-0.50mMS	9.12	8.86	8.70	9.33	12.67	9.50	11.23	12.00	14.29	11.10	13.88	13.98	15.18	14.47	13.22	14.81
T_6-0.50mMF	9.06	8.73	8.66	8.86	11.00	8.67	9.67	9.33	13.70	10.78	12.90	13.10	14.60	14.15	11.27	13.44
T_7-0.50mMS+F	9.12	8.86	8.76	9.33	12.67	9.56	11.25	12.00	14.46	11.33	13.96	14.26	15.28	14.65	13.94	15.04
T_8-0.75mMS	9.15	9.03	8.88	9.37	12.67	9.67	11.67	12.00	14.90	11.66	14.15	14.81	15.32	14.78	14.31	15.66
T_9-0.75mMF	9.11	8.79	8.66	9.10	11.00	8.87	9.83	10.67	13.72	10.82	12.98	13.10	15.10	14.35	11.39	13.66
T_{10}-0.75mMS+F	9.22	9.15	8.97	9.41	13.33	10.67	12.67	13.00	15.24	11.57	14.54	15.25	15.38	14.80	15.54	16.63
	SEm±	CD at 5 %	SEm±	CD at 5 %	SEm±	CD at 5 %	SEm±	CD at 5 %	SEm±	CD at 5 %	SEm±	CD at 5 %	SEm±	CD at 5 %	SEm±	CD at 5 %
Variety (V)	0.114	0.326	0.112	0.322	0.064	0.184	0.060	0.171	0.070	0.199	0.064	0.182	0.65	1.82	0.66	1.84
Treatments (T)	0.255	0.729	0.251	0.719	0.144	0.411	0.133	0.382	0.155	0.445	0.142	0.407	0.75	4.58	0.78	4.60
V×T	0.360	1.031	0.355	1.017	0.203	0.582	0.189	0.540	0.220	0.629	0.201	0.576	1.30	3.65	1.32	3.68

Conclusion

Growth attributes such as plant height, number of tillers plant^{-1} and plant biomass plant^{-1} recorded at 30 and 60 DAS showed that all the characters were significantly influenced under both the time of sowing. The effect of time of sowing registered higher reduction in all the parameters as compared to late sown variety sown under timely sown condition. The magnitude of reduction was more in case of NW-5054 compared to NW-2036. Delay in sowing of wheat than normal sowing date/ time decreased substantially almost all the yield and yield components measured *viz*; number of ear plant^{-1}, ear length and number of grains plant^{-1} which caused severe reduction in grain yield. Reduction percentage was more in case of NW-5054 compared to NW-2036.Temperature plays an important role in reduction of yield and yield components. Overall growth attributes and yield as well as yield components of wheat crop was adversely affected by time of sowing due to onset of high temperature during crop growth and particularly grain filling. Salicylic acid applied as seed soaking and foliar spray at 30 DAS and their combination significantly influenced growth attributes, physiological traits and yield and yield components. The combination of seed soaking and foliar spray of salicylic acid maximum improvement in all the characters in both the varieties at both the stages of sowing. But the maximum improvement was noted in late sown variety NW-2036 compared to timely sown variety NW5054. Physiological traits *viz*; relative water content and chlorophyll content in leaves observed at 30 and 60 DAS, all the characters were significantly influenced under both the time of sowing. The effect of time of sowing drastically reduced all the characters as in timely sown variety NW 5054 compared to late sown variety NW-2036 sown under timely sown. Reduction percentage was more in case of NW-5054 compared to NW-2036.

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