International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(4): 647-650

Received: 25-05-2019
Accepted: 27-06-2019

V Bhanuchandra Yadav
Department of Plant Physiology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Neha Anand
Department of Plant Physiology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

R Abhisree
Department of Plant Physiology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Correspondence
V Bhanuchandra Yadav
Department of Plant Physiology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Effect of salicylic acid on Morpho-physiological and biochemical attributes in normal and late sown genotypes of wheat (*Triticum aestivum* L.) under high temperature stress

V Bhanuchandra Yadav, Neha Anand and R Abhisree

Abstract
The study entitled "Effect of Salicylic acid on Morpho-Physiological and Biochemical attributes in Normal and Late Sown genotypes of Wheat (*Triticum aestivum* L.) under high Temperature Stress" field experiment was carried out at the Agriculture Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi with two wheat genotypes (HUW- 510 and HUW- 468) during the Rabi season 2017-18. Two wheat genotypes were sown on 15th November (timely sowing) and 15th December (late sowing) under standard package of practices. The effect of Salicylic acid on morphological and biochemical parameters of wheat genotypes under high temperature stress was determined. Salicylic acid at pre flowering and post flowering stages of two normal and late sown wheat genotypes was applied as foliar spray. SA treatments used in the present study are 1.0, 1.5, 2.0 mM SA. Analysis was done at pre flowering and post flowering stages in both genotypes of normal and late sown. In the present investigations, Morpho-physiological parameters like plant height, leaf area and dry weight were more influenced whereas less influenced were root length and total chlorophyll content and biochemical parameters are highly influenced by salicylic acid treatment such as proline content, protein content, Nitrate reductase activity. The highly responsive genotype was normal sown HUW-510 and low responsive genotype was late sown HUW-468. Salicylic acid at a concentration of 2mM SA was found to be the most effective in both genotypes. Thus, it indicates that the importance of these characters in selecting breeding programmes for development of superior genotypes. Results signify the role of salicylic acid in regulating the heat stress response of wheat; hence it could be used as a potential growth regulator under heat-stress as well as non-stress condition.

Keywords: Salicylic acid, high temperature stress, heat resistant, heat susceptible, normal sown, late sown, yield attributes

Introduction
Wheat (*Triticum aestivum* L.) is an important cereal grown as food grain in the world. The grain contains 60-80% carbohydrate, 8-15% protein, 1.5-2.0% fat, 1.5-2.0% inorganic ions and vitamins in small amounts. India is a major wheat growing country yet its yield is too low as compared to other developing countries. In India main cause of low yield is late sowing, Sowing date affects the growth and yield of wheat crop. A delay each day in sowing from 20th November onward decreases grain yield @ 39 kg per ha (Singh and Uttam,1994) [6]. Early planting produced greater number of spikes per m^2, heavier grain and highest grain yield per ha, while late planting affected these characters adversely (Shah *et al*. 2006) [5]. Salicylic acid (SA) has lately been documented as a plant hormone (Hayat *et al*., 2005) [1]. It acts as endogenous signaling molecule and plays an important role in growth (by initiating the mitotic activity) and development regulation of plant and also involved in interaction with other organisms and responses to several abiotic stresses (Miura and Tada, 2014) [3]. Salicylic acid plays miscellaneous physiological roles in plants together with thermogenesis, flower initiation, nutrient uptake, ethylene biosynthesis, stomatal movements, photosynthesis and enzyme actions (Hayat *et al*., 2005) [1]. Disease resistance and abiotic stress tolerance are supplementary roles which are associated to SA (Janda *et al*., 2007) [2]. Endogenous basal level of SA differs by several orders of magnitude in the diverse plant species and unfavorable environmental conditions have shown to boost the endogenous SA levels in plants (Pal *et al*., 2014) [4]. Two genotypes of wheat HUW-510 and HUW-468 used which were sown under normal and late sown condition.

Therefore, investigation was carried out with the objectives to study the effect of salicylic acid on physiological, biochemical attributes of wheat under high temperature stress experienced by the crop by sowing at normal and late conditions. Salicylic acid sprayed as treatments of three different concentrations 1 mM,1.5 mM and 2 mM was given only once at pre flowering and post flowering stages to the two wheat genotypes grown under normal (Non-stress) and late sowings (heat-stress). Among the Morpho- physiological indices plant height, root length, leaf area and dry weight were investigated in fully expanded leaves. The biochemical parameters studied in the present investigation are proline content, protein content, Nitrate reductase activity and total chlorophyll content. Observations were taken in upper fully expanded leaves for recording different physiological and biochemical readings. In this paper discussed about the morphological parameters like plant height, root length, leaf area and dry weight.

Materials and Methods

The experimental was conducted in the Agriculture Farm, Institute of Agricultural Sciences, Banaras Hindu University. Experimental site falls under sub-tropical zone of Indo-Gangetic plains and lies on the left bank of river Ganga. It is located on South- East direction of Varanasi city at 25° 26' N latitude, 83°9' E longitude and at an altitude of 76 meter above mean sea level.

The experiment was laid out in split-plot design with two varieties heat resistance and heat susceptible, two date of sowings normal sown and late sown, four treatments and replicated thrice.

Plant Height (cm)

Plant height of plants were taken from the base of the plant to the growing tip of main tiller with the help of meter scale, averaged and expressed in centimeter. Data were taken at pre flowering and post flowering stages of two genotypes of normal and late sown varieties with gap of 15 days between normal and late sown.

Root length (cm)

Root length was measured after the full emergence of the radicle post germination. Measurement was done by a standard scale from the base of the root to its tip. Data were taken at pre flowering and post flowering stages of two genotypes of normal and late sown varieties with gap of 15 days between normal and late sown.

Leaf area (cm^2)

The total leaf area of all the counted leaves was measured with the help of leaf area meter (Systronics Leaf Area Meter 211). Data were taken at pre flowering and post flowering stages of two genotypes of normal and late sown varieties with gap of 15 days between normal and late sown.

Dry weight (g $plant^{-1}$)

Root and shoot were excised, placed in an oven (NSW-142) at 105°C for 5 min then at 65°C till constant weight. Dry weight was taken by electrical balance, data were taken at pre flowering and post flowering stages of two genotypes of normal and late sown varieties with gap of 15 days between normal and late sown.

Results and Discussion

Plant Height (cm)

The plant height showed significant increase with increase in Salicylic acid concentration for treatment T4 (2mM SA) compared to all other treatments. In normal sown HUW-510 wheat genotype, highest plant height was recorded at post flowering stage compared to pre flowering stage under Treatment T4(2mM SA) and lowest plant height recorded for treatment T1(control) at pre flowering stage. In normal sown HUW-468 wheat genotype, highest plant height was recorded at post flowering stage compared to pre flowering stage for Treatment T4(2mM SA) and lowest plant height recorded for treatment T1(control) at pre flowering stage. In late sown HUW-510 genotype, highest shoot length was recorded at post flowering stage for T4 treatment and lowest shoot length was recorded at pre flowering stage for T1 treatment. In late sown HUW-468, highest shoot length was recorded at post flowering stage for T4 treatment and lowest shoot length was recorded at pre flowering stage for T1 treatment. Overall highest plant height was recorded in normal sown HUW-510 genotype at post flowering stage for T4 treatment and lowest plant height recorded in late sown HUW-468 genotype at pre flowering stage for T1 treatment. Normal sown genotype shows more plant height than late sown genotypes.

Root length (cm)

Root length of the plant showed very slight increase with increase in Salicylic acid concentration for T4 (2mM SA) compared to all other treatments. In normal sown HUW-510 wheat genotype, highest root length was recorded at post flowering stage compared to pre flowering stage for Treatment T4(2mM SA) and lowest root length was recorded for treatment T1(control) at pre flowering stage. In normal sown HUW-468 wheat genotype, highest root length was recorded at post flowering stage compared to pre flowering stage for Treatment T4(2mM SA) and lowest root length was recorded for treatment T1(control) at pre flowering stage compared to post flowering stages. In late sown HUW-510 genotype, highest root length was recorded at post flowering stage for T4 treatment and lowest root length was recorded at pre flowering stage for T1 treatment. In late sown HUW-468 genotype, highest root length was recorded at post flowering stage for T4 treatment and lowest root length was recorded at pre flowering for T1 treatment. Overall highest root length was recorded in normal sown HUW-510 genotype at post flowering stage for T4 treatment and lowest recorded in late sown HUW-468 genotype at pre flowering stage for T1 treatment. Normal sown genotype showed more root length than late sown genotype.

Leaf area (cm^2)

Leaf area of the plants showed significant increase with increase in Salicylic acid concentration for T4 (2mM SA) compared to all other treatments. In normal sown HUW-510 wheat genotype, highest leaf area was recorded at post flowering stage compared to pre flowering stage for Treatment T4(2mM SA) and lowest leaf area was recorded for treatment T1(control) at pre flowering stage. In normal sown HUW-468 wheat genotype, highest leaf area was recorded at post flowering stage compared to pre flowering stage for Treatment T4 (2mM SA) and lowest leaf area was recorded for treatment T1 (control) at pre flowering. In late sown HUW-510 genotype, highest leaf area was recorded at post flowering stage for T4 treatment and lowest leaf area was recorded at pre flowering stage for T1 treatment. In late sown

HUW-468, highest leaf area recorded at post flowering stage for T4 treatment and lowest leaf area was recorded at pre flowering stage for T1 treatment. Overall highest leaf area was recorded in normal sown HUW-510 genotype post flowering stage for T4 treatment and lowest recorded in late sown HUW-468 genotype pre flowering for T1 treatment. Comparatively normal sown genotype showed more leaf area than late sown genotype.

Dry weight of plant (g plant^{-1})

Dry weight of the plant showed significant increase with increase in Salicylic acid concentration for T4 (2mM SA) compared to all other treatments. In normal sown HUW-510 wheat genotype, highest dry weight was recorded at post flowering stage compared to pre flowering stage for Treatment T4(2mM SA) and lowest dry weight was recorded for treatment T1 (control) at pre flowering stage. In normal sown HUW -468 wheat genotype, highest dry weight was recorded at post flowering stage compared to pre flowering stage for Treatment T4 (2mM SA) and lowest dry weight was recorded for treatment T1(control) at pre flowering stage. In late sown HUW-510 genotype, highest dry weight was recorded at post flowering stage for T4 treatment and lowest dry weight was recorded at pre flowering stage for T1 treatment. In late sown HUW-468, highest dry weight was recorded at post flowering stage for T4 treatment and lowest dry weight recorded at pre flowering stage for T1 treatment. Overall highest dry weight was recorded in normal sown HUW-510 genotype at post flowering stage for T4 treatment and lowest recorded in late sown HUW-468 genotype at pre flowering stage for T1 treatment. Comparatively normal sown genotype shows more plant dry weight than late sown genotype.

Table 1: Effect of salicylic acid on plant height (cm) of wheat genotypes under normal and late sown conditions

Treatments	Normal sown				Late sown			
	Pre flowering		Post flowering		Pre flowering		Post flowering	
	HUW- 468	HUW-510	HUW-468	HUW- 510	HUW-468	HUW- 510	HUW- 468	HUW- 510
	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
T1	57.8	59.45	69.25	72.48	54.62	56.34	64.21	66.36
T2	58.23	60.34	70.32	73.61	55.34	56.98	64.59	67.56
T3	59.46	61.48	71.46	74.92	56.87	57.42	65.2	68.72
T4	60.25	63.67	72.58	75.32	57.23	58.64	66.21	69
SEm ±	0.01	0.04	0.02	0.1	0.13	0.07	0.16	0.05
C.D. at 5%	0.04	0.14	0.07	0.28	0.31	0.21	0.43	0.15

Table 2: Effect of salicylic acid on Root length (cm) of wheat genotypes under normal and late sown conditions

Treatments	Normal sown				Late sown			
	Pre flowering		Post flowering		Pre flowering		Post flowering	
	HUW- 468	HUW-510	HUW-468	HUW- 510	HUW-468	HUW- 510	HUW- 468	HUW- 510
	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
T1	14.24	15	19.45	21.2	12	13.5	16	18.25
T2	14.86	15.32	19.88	21.78	12.34	13.75	16.34	18.86
T3	15.39	15.85	20.27	22.47	12.86	14.78	16.97	19.42
T4	15.92	16.68	20.98	22.96	13.66	15.64	17.52	19.78
SEm ±	0.04	0.03	0.03	0.02	0.07	0.16	0.18	0.15
C.D. at 5%	0.14	0.12	0.12	0.07	0.21	0.43	0.56	0.48

Table 3: Effect of salicylic acid on Leaf area (cm2) of wheat genotypes under normal and late sown conditions

Treatments	Normal sown				Late sown			
	Pre flowering		Post flowering		Pre flowering		Post flowering	
	HUW- 468	HUW-510	HUW-468	HUW- 510	HUW-468	HUW- 510	HUW- 468	HUW- 510
	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
T1	44.72	46.52	59.26	62.76	40.48	42.58	48.52	53.26
T2	45.21	47.43	60	63.01	41.23	42.98	49.12	53.87
T3	45.92	48.02	60.57	63.65	41.78	43.21	49.87	54.31
T4	46.21	48.96	61.43	64.02	42.43	43.95	50.21	55.97
SEm ±	0.38	0.09	0.16	0.07	0.05	0.05	0.03	0.01
C.D. at 5%	0.95	0.34	0.43	0.19	0.13	0.13	0.11	0.04

Table 4: Effect of salicylic acid on Dry weight (g plant-1) of wheat genotypes normal and late sown under high temperature stress

Treatments	Normal sown				Late sown			
	Pre flowering		Post flowering		Pre flowering		Post flowering	
	HUW- 468	HUW-510	HUW-468	HUW- 510	HUW-468	HUW- 510	HUW- 468	HUW- 510
	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
T1	10.114	11.264	14.564	15.256	9.727	10.862	12.625	13.726
T2	10.787	11.662	14.991	15.861	10.231	11.237	13.122	14.281
T3	11.105	12.281	15.736	16.794	10.998	11.981	13.891	14.875
T4	11.731	12.916	16.363	17.423	11.431	12.644	14.355	15.427
SEm ±	0.02	0.05	0.03	0.1	0.14	0.05	0.02	0.19
C.D. at 5%	0.06	0.18	0.12	0.04	0.37	0.13	0.07	0.56

T_1 = Control without Salicylic acid
T_2 = 1mM Salicylic acid
T_3 =1.5mM Salicylic acid
T_4 = 2mM Salicylic acid

Conclusion

The study thus revealed that physiological and biochemical parameters of wheat genotypes may be improved by treatment with salicylic acid (1.0 mM, 1.5 mM, 2 mM SA) under normal sown and late sown wheat genotypes under high temperature stress. In the present investigations, Morpho-physiological parameters like plant height, leaf area and dry weight were more influenced whereas less influenced were root length. Plant height was increased with increase in concentration of SA maximum recorded in post flowering stage normal sown HUW-510 genotype. Root length was increased with increase in concentration of SA maximum recorded in post flowering stage normal sown HUW-510 genotype. Leaf area was increased with increase in concentration of SA maximum recorded in post flowering stage normal sown HUW-510 genotype. Dry weight was increased with increase in concentration of SA maximum recorded in post flowering stage normal sown HUW-510 genotype. The highly responsive genotype was normal sown HUW-510 and low responsive genotype was late sown HUW-468. Salicylic acid at a concentration of 2mM SA was found to be the most effective in both genotypes. Thus, it indicates that the importance of these characters in selecting breeding programmes for development of superior genotypes.

References

1. Hayat S, Fariduddin Q, Ali B, Ahmad A. Effect of salicylic acid on growth and enzyme activities of wheat seedlings. Agronomy Journal. 2005; 53:433-437.
2. Janda T, Szalai G, Lesko K, Yordanova R, Apostol S, Popova LP. Factors contributing to enhanced freezing tolerance in wheat during frost hardening in the light. Phyto chemistry. 2007; 68:1674-1682.
3. Miura K, Tada Y. Regulation of water, salinity, and cold stress responses by salicylic acid. Frontier of Plant Science. 2014; 5:213-227.
4. Pal M, Kovacs V, Szalai G, Soos V, Ma X, Liu H *et al*. Salicylic acid and abiotic stress responses in rice. Journal of Agricultural Crop Science. 2014; 200:111-114.
5. Shah WA, Bakht J, Ullah T, Khan WA. Effect of sowing on the yield and yield components of different wheat varieties. Journal of Agronamy. 2006; 5(1):106-110.
6. Singh VPN, Uttam SK. Influence of sowing dates on yield of wheat cultivar under saline sodic conditions in Central Uttar Pradesh. Indian Agriculture. 1994; 38(1):61-64.