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Studies on foliar application of thio-urea on physiological, biochemical and yield potential in different wheat [*Triticum aestivum* L.] Undertwo conditions

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Abstract
The field experiments were conducted at Student Instructional Farm of SVNU Sagar, during Rabi 2018-19 and 2019-20. The objective of investigation was to study the effect of foliar applied potassium nitrate and thio-urea with different doses on plant traits (physiological, biochemical, yield and its components) of two wheat varieties under drought and irrigated condition. It was designed in split-split plot design with three replications. The two conditions *i.e.*, drought (I_0) and irrigated (I_1) conditions were allocated in the main plots and two wheat varieties *i.e.*, V_1 (K-402) and V_2 (K-607) in sub plot and for each five chemical treatments were applied as foliar spray at heading stages by500 ppm (T_3) and 1000 ppm thio-urea (T_4), along with control (T_0) in sub-sub plots. The significantly higher grain yield (5.30& 5.12gm) with best morpho-physiological, phenological and biochemical traits can be obtained by foliar application of 500ppm thio-urea (T_3) with both condition of *i.e.*, drought (I_0) and irrigated (I_1) of wheat crop. Next to this were 500ppm thio-urea (T_3) *i.e.*, 5.30& 5.26, 1000ppm thio-urea (T_4) *i.e.*, 5.12&5.08 as compare to control (T_0) *i.e.*, 4.30& 4.13 gm. Among cultivars, maximum responsive was K-402 (V_1) in most of traits and gave significantly higher grain yield (5.30& 5.23) and minimum in K-607 (V_2) *i.e.*, 5.12& 5.08 gm with both concerning experimental years.

Keywords: Physiological, biochemical, yield attributes, foliar spray of thio-urea on drought and irrigated conditions

Introduction

Wheat consumption worldwide is estimated to 817 million tons by 2030 and production would need to increase at 22.6-43.6% in different countries at the current production level to meet the estimated consumption demand. India is the largest wheat producing country in the world after China. The wheat production has increased manifold from 6.60 million tonnes at the time of independence to 107.86 million tons in (Anonymous, 2019-20) [2]. The productivity has witnessed an increase by 473 per cent *i.e.* from 670 kg/ha to 3533 kg/ha during the above period. Despite delayed sowing, the country recorded 38.99 million hectares. Theclearly indicates the strength of systematic and planned wheat research in the country. It may be recalled that the total wheat production of the country during 1947-48 was just 5.6 million tons with average productivity of less than one t/ha. Out of total area of wheat in India, Uttar Pradesh alone contributes area 9.65 million hectare and production near about 26.87 million tons with productivity of 27.72 q ha-1. Wheat consumption in India estimated to surpass 110 million tons of wheat will be needed by 2020.

Drought is the most prevailing problem and the factor known to be serious for its impacts on crop limitations (Souza *et al*., 2004) [16]. This kind of abiotic stress often occurred as consequence of the reduction of the water level that reaches earth due to extreme atmospheric conditions which frequently cause water loss via transpiration and evaporation. Generally, water scarcity resulted from either drought or soil salinity influenced crop plant's morphology, physiology and could lead to cellular and organelles deformation. Drought specific impacts on biochemical and molecular processes lead to stomata closure with consecutive decrease in rates of transpiration, pigment content, photosynthesis, caused protein alterations and ended with growth inhibition.

At present, wheat growth has been seriously influenced by drought in many regions (Abdel kader *et al*., 2010) [1]. Many techniques were invented to assess wheat tolerance; as such, seed priming and exogenous applications before and during cultivation were efficiently used as methods of plant mitigations under drought stress. Furthermore, glycine betaine application to plants was effective with stabilizing the quaternary structures of enzymes and complex proteins, lipids of photosynthetic apparatus and in maintaining highly ordered state of membranes. Although physiological processes that stimulated these improvements are not yet discovered, the seed priming was achieved progressively in many plant species and was potent in improving yield quality and yield amounts (Harris *et al*., 2002) [8]. On the other hand, thio-urea (*Th*), a sulfhydryl compound, was used for foliar treatments and enhanced an increase in biological yieldandeconomical yield. Moreover, *'Th'* treatments lead to grain yield increase by 23.9% over control.

Materials and Methods

All facilities related to study were available at the Experimental Research Student Instructional Farm of S. V. N. University Sagar. Geographically Sagar is located of 23.83^0 N Longitude of 78.71^0 E and above 427 meters sea level. It lies in the sub-tropical regions where wheat is grown in the Rabi seasons. A total dose of 150 kg/ha Nitrogen, 80 kg/ha Phosphorus and 60 kg/ha Potash, through urea, single super phosphate (SSP) and murate of potash (MOP) were used in the experiment.

Canopy temperature depression ^{0}C (CTD)

It was measured by Infra-Red Thermo-meter. (Tele temp AG-42 USA)

a) The difference between ambient and canopy temperature has to be entered in the data book.
b) Canopy in the area earmarked for final observation may be focused for CTD measurement.
c) Care should be taken to see that the angle and the distance between the canopy and the Infra-red Thermo-meter remain constant for each plot.
d) Observation should be recorded between 11.00 a.m. to 01.00 p.m. (mid-day).

Chlorophyll fluorescence (F_v/F_m)

Chlorophyll fluorescence was measured at pre-anthesis and 15 days after anthesis. It was determined by fluorescence measurement system (Handy PEA Hansatech Electronics Ltd. UK). Fluorescence was calculated to determine the degree of thermo inhibition (Havaux 1993, 2001) [9, 10].

Chlorophyll content (mg g^{-1})

Chlorophyll content was measured by method given by Arnon and Stout, (1949) [3].

Protein Content (%)

Protein content (%) = Nitrogen content (%)* 5.83 (Factor)

The experiment consisted of two conditions in main plot, drought (I_0) and irrigated (I_1), two varieties in sub plot (V_1) K-402 and (V_2) K-607, three treatments in sub-sub plot (T_0) control, (T_3) 500ppm thio-urea and (T_4) 1000ppm thio-urea foliar spray at heading stage. These three treatment combinations were replicated in three replications in split-split plot design. Observations were recorded on physiological characteristics *viz.* canopy temperature depression and chlorophyll fluorescence at heading stage, biochemical parameter *viz.* chlorophyll content and protein content, yield and yield attributes *viz.* biological yield per plot (kg) and economical yield per plot (kg). All the data on physiological, biochemical parameters and yield contributory characters were statically analyzed by the methods suggested by Fisher (1937) [7].

Result and Discussion

The physiological traits, the canopy temperature depression measured highest in thio-urea 500ppm and thio-urea 1000ppm with combination 3.65 ^{0}C and 3.56^{0}C at least control 2.27 ^{0}C, chlorophyll fluorescence measured by 0.765 and 0.757 as compared to control 0.625 for both corresponding years were significantly in table no. 1. The canopy temperature depression decreased and chlorophyll fluorescence was increase in drought condition. Water stress is generally characterized by decrease in water potential, resulting in wilting, stomata closure and reduced growth. Earlier reports by Sharma *et al.* (2008) [15], Karim *et al.*, (2012) [11], Kaya *et al.*, (2013) [12] and Atique *et al.*, (2014) [4] also support these observations.

The biochemical traits as presented in Tables no. 2.The chlorophyll content (gm g^{-1}) andthe protein content in grain (%) were estimated non-significantly higher in thio-urea 500ppm and thio-urea 1000ppm with combination of the chlorophyll content (gm g^{-1})2.28 and 2.12 as compared to control 1.76in irrigated condition and the protein content in grain (%) 12.42 and 12.32 drought condition at least control 10.27 in irrigated conditionduring both experimental years. Improvement in chlorophyll due to foliar application of thio-urea may be ascribed the role of thio-ura in improving many physiological growth processes and delay plant leaves senescence as well as photosynthetic activity. The same types of observation were also found by the studies of Saleem *et al.*, (2011) [14] and El-Yazied, *et al.*, (2012) [6] in wheat crop.

The data pertaining on yield and its attributes as presented in Tables no.3.Revealed that it varied significantly and non-significantly higher in thio-urea 500ppm and thio-urea 1000ppm during both the years. The biological yield per plot 8.236 and 8.172 kg at lowest control 3.667and economical yield per plot 1.680 and 1.555 kg at minimum control 0.425 kgdrought and maximum in irrigated condition both years of experimentation.The reduced ear length at anthesis is due to reduced number of nodes and less node to node distance on the rachis. Moreover it was also observed by Taban *et al.* (2000) [17] that under environmental stress conditions the spike length remains stable.

Normal required number of irrigations is compulsory for ideal crop growth and production but when there is limited water available, it is necessary to identify growth stage of the crop where irrigation could be skipped with minimum loss in grain yield. Final grain yield of wheat depends on its efficient use of water. Normal water at flowering increased photosynthetic rate and also enhanced duration of grain filling. Due to water stress at heading reduced weight of 1000-grains was reported by Nishi *et al.*, (2006) [13] in mungbean and in wheatby Awaneet *et al.*, (2014) [5].

Table 1: Effect on foliar application of thio-urea on physiological parameter.

Treatments		2018-19						2019-20					
		Canopy Temperature Depression			Chlorophyll Fluorescence			Canopy Temperature Depression			Chlorophyll Fluorescence		
		Control (T_0)	500ppm Thio-urea (T_3)	1000ppm Thio-urea (T_4)	Control (T_0)	500ppm Thio-urea (T_3)	1000ppm Thio-urea (T_4)	Control (T_0)	500ppm Thio-urea (T_3)	1000ppm Thio-urea (T_4)	Control (T_0)	500ppm Thio-urea (T_3)	1000ppm Thio-urea (T_4)
I_0	V_1	2.27	2.40	2.33	0.742	0.762	0.752	2.30	2.46	2.38	0.756	0.764	0.757
	V_2	2.36	2.65	2.54	0.749	0.761	0.757	2.40	2.60	2.56	0.753	0.765	0.756
I_1	V_1	3.31	3.39	3.37	0.628	0.650	0.645	3.35	3.42	3.40	0.635	0.658	0.652
	V_2	3.38	3.53	3.46	0.625	0.655	0.648	3.40	3.55	3.50	0.630	0.660	0.653
Factors		I	V	T	I	V	T	I	V	T	I	V	T
SE (d)		0.07	0.08	0.06	0.008	0.006	0.006	0.03	0.04	0.06	0.006	0.001	0.003
C.D. at 5%		0.32	NS	0.13	0.035	NS	0.012	0.13	0.09	0.11	0.025	NS	0.009

Table 2: Effect on foliar application of thio-urea on biochemical parameter

Treatments		2018-19						2019-20					
		Chlorophyll Content			Protein Content			Chlorophyll Content			Protein Content		
		Control (T_0)	500ppm Thio-urea (T_3)	1000ppm Thio-urea (T_4)	Control (T_0)	500ppm Thio-urea (T_3)	1000ppm Thio-urea (T_4)	Control (T_0)	500ppm Thio-urea (T_3)	1000ppm Thio-urea (T_4)	Control (T_0)	500ppm Thio-urea (T_3)	1000ppm Thio-urea (T_4)
I_0	V_1	1.95	2.29	2.12	11.41	12.20	12.04	1.98	2.24	2.15	11.45	12.25	12.08
	V_2	1.80	2.14	2.01	11.47	12.38	12.28	1.85	2.18	2.06	11.50	12.42	12.32
I_1	V_1	1.85	2.24	2.08	10.30	11.41	11.35	1.90	2.28	2.12	10.35	11.45	11.38
	V_2	1.76	2.09	2.02	10.27	11.32	11.22	1.80	2.14	2.06	10.30	11.36	11.25
Factors		I	V	T	I	V	T	I	V	T	I	V	T
SE (d)		0.01	0.01	0.02	0.05	0.06	0.08	0.03	0.03	0.06	0.08	0.07	0.17
C.D. at 5%		NS	0.02	0.04	0.13	NS	0.17	NS	0.09	0.12	0.36	NS	0.34

Table 3: Effect on foliar application of thio-urea on yield parameter

Treatments		2018-19						2019-20					
		Biological Yield/Plot (kg)			Economical Yield/Plot (kg)			Biological Yield/Plot (kg)			Economical Yield/Plot (kg)		
		Control (T_0)	500ppm Thio-urea (T_3)	1000ppm Thio-urea (T_4)	Control (T_0)	500ppm Thio-urea (T_3)	1000ppm Thio-urea (T_4)	Control (T_0)	500ppm Thio-urea (T_3)	1000ppm Thio-urea (T_4)	Control (T_0)	500ppm Thio-urea (T_3)	1000ppm Thio-urea (T_4)
I_0	V_1	3.667	4.267	4.167	0.425	0.467	0.450	3.669	4.269	4.168	0.428	0.495	0.460
	V_2	3.933	4.567	4.433	0.450	0.517	0.500	3.935	4.569	4.435	0.455	0.520	0.510
I_1	V_1	7.000	8.233	8.167	1.175	1.675	1.550	7.100	8.236	8.172	1.180	1.680	1.555
	V_2	6.400	7.700	7.667	1.067	1.442	1.317	6.410	7.715	7.672	1.167	1.452	1.325
Factors		I	V	T	I	V	T	I	V	T	I	V	T
SE (d)		0.29	0.35	0.29	0.04	0.05	0.09	0.07	0.06	0.14	0.03	0.01	0.03
C.D. at 5%		NS	NS	0.58	0.19	NS	0.19	0.283	NS	0.40	0.12	0.03	0.08

Conclusions

The results summarised as irrigated condition (I_1), variety K-402 (V_1) among varieties, 500ppm thio-urea (T_3) among treatments were found significantly superior for most of physiological *i.e.*, Canopy temperature depression ^{0}C (CTD)and chlorophyll fluorescence, biochemical traits *i.e.*, chlorophyll content(mg g^{-1})and protein content (%). The summarizedas irrigated condition (I_1), variety K-402 (V_1) among varieties, 500ppm thio-urea (T_3) among treatments were found significantly superior for most of yield components *i.e.*, biological yield plot^{-1}, economical yield plot^{-1}after harvesting were examined significant also for irrigated condition (I_1) and 500ppm thio-urea (T_3) but variety K-402 (V_1) for yield per pose and other traits in (V_2) K-607 variety during both corresponding years. Finally, it may be concluded that significantly higher yield components with best physiological, and biochemical traits can be obtained by foliar application of thio-urea 500ppm (T_3) with both condition of sowing *i.e.*, irrigated (I_1) and drought (I_0) of wheat crop. Next to this was1000ppm thio-urea (T_4) as compare to control (T_0). Among cultivars, maximum responsive was K-402 (V_1) in most of traits and gave significantly higher yield and minimum in K-607 (V_2) with both concerning experimental years.

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