Effect of foliar application of thio-urea on biochemical parameters in Wheat (Triticum aestivum L.) cultivars

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Abstract
These experiments have been conducted in order to study the effect of foliar application of thio-urea doses on biochemical of two varieties in two sowing conditions at Student Instructional Farm of C. S. Azad University of Agriculture and Technology, Kanpur during the Rabi season of 2017-18 and 2018-19. The experimental design was split-split plot design in which sowing conditions was in main plot (D1: timely sowing, D2: late sowing), two cultivars (V1: K-607, V2: K-402) in subplot while five treatments in these one doses thio-urea (T1: 500ppm, T2: 750ppm, T3: 1000ppm, T4: 1500ppm) with control (T5) without spray in sub-sub plot with three replications. Results showed high significantly effect of sowing condition, variety and treatment on Chlorophyll (SPAD) Value-sown condition (D1) over late sown condition D2 with 42.1 and 41.8; 41.6 and 41.8, effect of treatment: T1 (2.3 and 2.3) followed by T2 (2.2 and 2.2), T3 (2.2 and 2.1) while, least chlorophyll value was in treatment T5 (2.1 and 2.0) and T6 (1.8 and 1.8) in both years of experimentation. Fat Content (%) timely sown condition (D1 i.e., 0.98 and 0.97 as compare to late sown condition D2 i.e., 0.97 and 0.96), effect of variety (V1 with 0.98 and 0.97 g and V2 with 0.97 and 0.96) and effect of treatment (T2 (1.04 and 1.03) showed statistically higher fat content followed by T3 (0.98 and 0.96), T5 (0.96 and 0.93) and T4 (0.94 and 0.96) while lowest in treatment T6 (0.93 and 0.97) during both year of experimentation. Protein content (%) effect of condition (Maximum protein content (11.5%) accumulated in D1 while, minimum (11.0%) in D2) effect of variety highest (11.5%) protein content numerically recorded in V1 and lowest in V2 (11.1%) and effect of treatment T2 gave statistically maximum mean value T6 (11.7 and 11.8) protein content (%) during these experimentation were found significantly with sowing conditions, varieties, treatments and their interaction in both years. Totally conclusion that timely sowing date (D1), cultivar (V1), and treatment (T2: thio-urea 750ppm) were superior to others.

Keywords: Thio-urea, chlorophyll, fat content, protein content

Introduction
Wheat (Triticum aestivum L.) is the second most important staple food crop of the world on account of its wide adaptability to different agro-climatic and soil conditions. Wheat is the world’s most outstanding crop that excels all other cereals both in area and production, known as king of cereals. It is also one of the most nutritious cereals and its contribution to human diet puts it in the first rank of plants that feed the world (Costa et al., 2013) [3]. India is the largest wheat producing country in the world after China. The wheat production has increased manifold from 6.60 million tons at the time of independence to 97.44 million tons (Anonymous, 2017-18) [1]. Thio-urea, also called thiocarbamide, an organic compound that resembles urea but contains sulphur instead of oxygen; i.e., the molecular formula is CS (NH2)2, while that of urea is CO (NH2)2. Like urea, it can be prepared by causing a compound with the same chemical composition to undergo rearrangement, as by heating ammonium thiocyanate (NH4SCN). A method of preparation more commonly used consists of the addition of hydrogen sulphide to cyanamide. Thio-urea, a sulphhydrol compound is known to improve pulse productivity and its role as a drought ameliorant is well established under the arid and semi-arid regions (Sahu et al., 1993) [10]. This is depended on the efficiency of photosynthetic translocation in crop during grain filling period when developing grains are the storing sink. Nishi et al. (2006) [8] results revealed that thio-urea application showed favorable effects of on
net photosynthesis and levels of leaf metabolites viz. total chlorophyll, starch, reducing sugars and soluble protein as well as nitrate reductase activity. Bavita et al. (2015) also evaluated the potential of thio-urea in improving the terminal heat resistance in bread wheat. Thio-urea application also increased the total soluble proteins, amino acids and chlorophyll contents in all the tested genotypes.

Materials and Methods

The present study was carried out at the Experimental Students Farm, Nawabganj of Chandra Shekhar Azad University of Agriculture and Technology Kanpur, India, during Rabi season 2017-18 and 2018-19. Geographically Kanpur is located of 26.30° N Longitude of 80.15° E and above 127 meters sea level. The experimental design was split-split plot design in which sowing conditions was in main plot (D1: Timely sowing, D2: Late sowing), two cultivars (V1: K-607, V2: K-402) in subplot while five treatments in these

| Table 1: Effect on foliar application of thio-urea on Chlorophyll (SPAD) value at heading stage of wheat cultivars under timely and late sown conditions |
| Varieties/Conditions | 2017-18 | 2018-19 |
|-----------------------|---------|---------|
|                       | V1      | V2      | Mean | V1      | V2      | Mean |
| D1                    | 42.1    | 42.0    | 42.1 | 41.3    | 42.2    | 41.2 |
| D2                    | 42.3    | 40.9    | 41.6 | 41.7    | 42.0    | 41.8 |
| Mean                  | 42.2    | 41.4    | 42.7 | 42.1    | 42.1    | 42.1 |

| Treatment/Conditions | 2017-18 | 2018-19 |
|----------------------|---------|---------|
|                       | T0     | T1     | T2     | T3     | T4     | Mean | T0     | T1     | T2     | T3     | T4     | Mean |
| D1                   | 42.0   | 42.0   | 41.7   | 42.6   | 42.0   | 42.1 | 41.3   | 42.5   | 41.6   | 41.9   | 41.6   | 41.8 |
| D2                   | 42.3   | 42.0   | 41.9   | 40.6   | 41.1   | 41.6 | 40.9   | 42.0   | 42.1   | 42.4   | 41.9   | 41.8 |
| Mean                 | 42.2   | 42.0   | 41.8   | 41.6   | 41.5   | 42.1 | 41.1   | 42.3   | 41.8   | 42.1   | 42.1   | 41.7 |

| Treatment/Varieties | 2017-18 | 2018-19 |
|---------------------|---------|---------|
|                      | T0     | T1     | T2     | T3     | T4     | Mean | T0     | T1     | T2     | T3     | T4     | Mean |
| V1                   | 42.7   | 41.5   | 41.8   | 42.4   | 42.6   | 42.2 | 40.5   | 42.3   | 41.4   | 41.7   | 41.4   | 41.5 |
| V2                   | 41.6   | 42.5   | 41.8   | 40.8   | 40.4   | 41.4 | 41.7   | 42.2   | 42.2   | 42.6   | 42.0   | 42.1 |
| Mean                 | 42.2   | 42.0   | 41.8   | 41.6   | 41.5   | 42.1 | 41.1   | 42.3   | 41.8   | 42.1   | 42.1   | 41.7 |

| Combinations         | 2017-18 | 2018-19 |
|----------------------|---------|---------|
|                      | T0     | T1     | T2     | T3     | T4     | Mean | T0     | T1     | T2     | T3     | T4     | Mean |
| D1                   | V1     | 42.0   | 41.3   | 41.2   | 42.5   | 43.7 | 40.5   | 42.2   | 42.1   | 43.2   | 41.3   | 41.4 |
|                     | V2     | 42.0   | 42.6   | 42.3   | 42.6   | 40.3 | 42.1   | 42.8   | 42.1   | 42.5   | 42.8   | 41.8 |
| D2                   | V1     | 43.3   | 41.7   | 42.4   | 42.2   | 41.6 | 40.5   | 42.5   | 41.7   | 42.1   | 41.5   | 42.1 |
|                     | V2     | 43.1   | 42.3   | 41.3   | 43.9   | 40.5 | 41.3   | 41.6   | 42.4   | 42.7   | 42.2   | 42.2 |
| Factor               | D      | V      | T      | DxV    | DxT    | VxT   | DxVxT  | D      | V      | T      | DxV    | DxT    | VxT   |
| SE (d)               | 0.7    | 0.2    | 0.8    | 0.3    | 1.1    | 1.1   | 0.05   | 0.1    | 0.6    | 0.2    | 0.8    | 1.2    |
| C.D. at 5%           | NS     | 0.78   | NS     | NS     | NS     | NS    | NS     | 0.50   | NS     | NS     | NS     | NS     |

Effect of condition: The mean value of conditions showed that chlorophyll value (SPAD) statistically reduce in timely sown condition (D1) over late sown condition (D2) with 42.1 and 41.8; 41.6 and 41.8 during concerning years (2017-18 and 2018-19), respectively.

Effect of varieties: The both years mean value of chlorophyll value (SPAD) (fresh tissue) observed significantly highest in the variety V1 i.e., 42.2, 41.5 and less than V2 i.e., 41.4 and 42.1, respectively.

Effect of treatments: The significantly higher mean value of chlorophyll content in mg g⁻¹ fresh tissue with treatment T1 (2.3 and 2.3) followed by T2 (2.2 and 2.2), T3 (2.2 and 2.1) while, least chlorophyll value was in treatment T4 (2.1 and 2.0) and T0 (1.8 and 1.8) in both years of experimentation, respectively.

Interaction effect between condition and varieties: The data on conditions with varieties did not show significant effect on chlorophyll value (SPAD) (Fresh tissue), however maximum value of chlorophyll value was found in combination D1V1 (42.1, 41.3) and minimum in D2V2 (42.9, 40.9) for both years.

Interaction effect of condition and treatments: It is visualized that the value of chlorophyll content fresh leaf of both experimental years was not significant effect but numerically maximum value showed in combination D1T1 with 42.6 and 41.9 followed by D2T1 with 42.0 while minimum in D1T0 with 42.0 and 41.3 fresh tissue, respectively.

Interaction effect of varieties and treatments: The interaction effect of varieties and treatments to chlorophyll value (SPAD) fresh leaf did not give significant effect for both years, but numerically higher value was in combination V1T2 (42.2, 42.5) followed by V1T4 42.4, 41.7 chlorophyll value and while least in V2T0 (41.6, 41.7).

Interaction effect among condition, varieties and treatments: Although, the interaction of sowing dates,
varieties and treatments have shown non-significant effect on chlorophyll value (SPAD) during both years. But numerically maximum D1V1T2 i.e., 42.3, 42.1 over D1V2T3 i.e., 42.5, 41.3 and minimum in D1V2T0 i.e., 41.3, 40.5 respectively. Saleem et al., (2011) [11] and El-Yazied and Mady (2012) [4]

[2] Fat content (%)
The data on Fat content is overlooked from Table 2, which affected due to condition, varieties, foliar applied thiourea and their interactions.

Table 2: Effect on foliar application of thiourea on Fat content in grain of wheat cultivars under timely and late sown conditions

| Varieties/Conditions | Treatment/Varieties | 2017-18 | 2018-19 |
|----------------------|--------------------|---------|---------|
|                      | V1                 | V2      | Mean    | V1     | V2      | Mean    |
| D1                   | 0.97               | 0.98    | 0.97    | 0.94   | 0.98    | 0.96    |
| D2                   | 0.96               | 0.96    | 0.96    | 0.98   | 0.98    | 0.98    |
| Mean                 | 0.97               | 0.97    | 0.97    | 0.94   | 0.98    | 0.98    |

| Treatment/Conditions | Varieties/Conditions | 2017-18 | 2018-19 |
|----------------------|----------------------|---------|---------|
|                      | T0                  | T1      | T2      | T3      | T4      | Mean    | T0     | T1     | T2     | T3     | T4     | Mean    |
| D1                   | 0.93                | 0.95    | 1.04    | 0.98    | 0.98    | 0.98    | 0.98    | 0.94   | 0.98   | 0.94   | 0.97   | 0.97   |
| D2                   | 0.94                | 0.93    | 1.03    | 0.99    | 0.97    | 0.97    | 0.97    | 0.98   | 0.94   | 0.93   | 0.97   | 0.96   |
| Mean                 | 0.93                | 0.94    | 1.04    | 0.96    | 0.98    | 0.97    | 0.97    | 0.96   | 1.03   | 0.93   | 0.96   | 0.96   |

| Combinations         | Factor              | 2017-18 | 2018-19 |
|----------------------|---------------------|---------|---------|
|                      | D                   | V       | DxV     | DxT     | VxT     | DxVxT   | D       | V      | DxV    | DxT    | VxT    | DxVxT   |
|                      | SE (d)              | 0.014   | 0.006   | 0.018   | 0.026   | 0.026   | 0.037   | 0.006  | 0.01   | 0.02   | 0.01   | 0.02   | 0.02    |
|                      | C.D. at 5%          | NS      | NS      | 0.04    | NS      | NS      | NS      | NS     | NS     | NS     | NS     | NS     | NS      |

Effect of condition: The mean value of Fat content (%) statistically non-significantly increase in Timely sown condition D1 i.e., 0.98 and 0.97 as compare to late sown condition D2 i.e., 0.97 and 0.96 for year 2017-18 and second year 2018-19, respectively.

Effect of varieties: The non-significantly highest mean value of fat content was in variety V1 with 0.98 and 0.97 g and V2 with 0.97 and 0.96 for both years of experimentation.

Effect of treatments: The mean value of Fat content significantly influenced by treatments in both experimental years. Among the treatments T2 (1.04 and 1.03) had showed statistically higher fat content followed by T3 (0.98 and 0.96), T1 (0.96 and 0.92) and T4 (0.94 and 0.96) while lowest in treatment T0 (0.93 and 0.97) with both experimental years.

Interaction effect between condition and varieties: Though, the data on the Fat content found non-significant effect but numerically maximum test weight in combination D1V2 with 0.98 and D2V2 at II position with 0.98 and 0.97 as well as minimum in combination D2V1 with 0.96 and 0.98 during both years of experimentation.

Interaction effect of condition and treatments: It is visualized that the fat content did not show significant effect during both year, respectively. In combination D1T2 i.e., 42.0 and 41.5 g followed by D1T4 i.e., 41.9 and 41.1 g however, lowest in combination D2T0 i.e., 40.5 and 39.9 g, non-significant effect during second year respectively.

Interaction effect of varieties and treatments: The interaction effects of varieties and treatments have noted non-significant effect on test weight (g). The non-significantly highest value in combination D1T2 (41.7 and 41.6) followed by V1T4 (41.1 and 41.2) at par V1T2, V1T4 (40.6) and least in V1T0 (40.5 and 40.4) for both experimental years.

Interaction effect among condition, varieties and treatments: Since, interaction effect of conditions, varieties and treatments on test weight was not significant but numerically more value of combination in D1V2T1 (41.7 and 41.6) followed by D2VT1 (42.0 and 41.4) g and D2VT2 (42.60 and 40.5 g) while, least in combination D1V2T0 (39.3 and 40.3 g) for both corresponding years, respectively. Pelikan et al., (1993) [9] and Shubhra (2006) [13]

[3] Protein content in grain (%): The data elucidated for protein content (%) as affected by condition, varieties, treatments of foliar applied thiourea and their interaction effects are presented in Table 3.
Interaction effect of condition, varieties and treatments: The interaction effect of conditions on protein content was significant. The maximum protein content was observed in D1 treatment, followed by D2 and untreated plants. The interaction effect of varieties and treatments was also significant. The highest protein content was observed in variety K, followed by varieties V and T.

Effect of condition: Though statistically mean value of conditions indicated non-significant effect but numerically maximum protein content (11.5%) accumulated in D1 while, minimum (11.0%) in D2 during both year.

Effect of varieties: The first year mean value of protein content examine significant effect on varieties. Although, highest (11.5%) protein content numerically recorded in V1 and lowest in V2 (11.1%) for year 2017-18 and 2018-19.

Effect of treatments: The treatment significantly influence on protein content during both years. Among treatments, T2 gave statistically maximum mean value T0 (11.7 and 11.8) protein content (%) during both year of experimentation. But minimum value both years of experimentation untreated control T0 i.e., 10.6 and 10.9.

Interaction effect of condition and varieties: Though the interaction of conditions and varieties was non-significant with regards to protein content, but combination D1V2 had produced high (11.6 and 11.7%) for both year and D1V1 numerically less (10.9 and 11.3%) with years i.e., 2017-18 and 2018-19 experiment.

Interaction effect of condition and treatments: Interaction of sowing dates with treatments has conditions significant effect on protein content. Numerically, the combination D1T2 i.e., 11.8 and 11.5% accumulated highest protein content and lowest in D2T0 (10.2 and 11.0%) in the year 2017-18 and 2018-19.

Interaction effect of varieties and treatments: The interaction effect of varieties with treatments has indicated non-significant effect on protein content (%). The combination V1T0 showed lowest (10.7 %) and highest protein content combination V3T2 (11.6 %) in first year and significant in V1T2 i.e., 12.1 % and V2T0 (10.6 %) during both years.

Interaction effect of condition, varieties and treatments: The interaction effect of sowing dates, varieties and treatments have indicated whether Significant effect in both years. The maximum protein content i.e., D1V1T1 (11.8 & 11.8 %) which was exhibited by combination D1V2T0 (10.3 & 10.7 %). Gupta et al., (2013)[5] and Kanani et al., (2013)[7], Sharma et al., (1991)[12], Rizwan et al., (2011), Sridhar et al., (2005)[14].

Conclusion
Finally, it may be concluded that significantly biochemical traits can be obtained by foliar application of 750ppm thiourea (T2) with both condition of sowing in the both years i.e., timely sown (D1) and Late sown condition (D2) of wheat crop. Next to this were (T3) i.e., 5.3 and 5.1 g, 500ppm thiourea (T1) i.e., 5.2 and 5.4 g, 1500ppm thiourea (T2) i.e., 5.2 and 5.7 g as compare to control (T0) i.e., 4.39 and 4.35 g. Among cultivars, maximum responsive was K-402 (V2) in most of traits and gave significantly biochemical traits 5.5 and 5.9 g minimum in K-607 (V1) i.e., 5.0 and 4.9 g with both concerning experimental years.

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