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INFLUENCE OF ORGANIC MANURES ON DROUGHT STRESS AT DIFFERENT GROWTH STAGES OF WHEAT

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Abstract

A pot experiment was conducted in the net house of the Agronomy department, Sher-e-Bangla Agricultural University, Dhaka during the period from November, 2018 to March, 2019 to evaluate the suitable organic source to mitigate the drought stress impact on wheat. The experiment comprised two factors viz. factor A: Three levels of organic manures, i) O_0 = Control (Without organic manure), ii) O_1 = Cowdung (10 t/ha), iii) O_2 = Poultry litter (5 t/ha), and factor B: four levels of drought i) D_0 = Control (without drought), ii) D_1 = Crown root initiation stage (at 20-29 DAS), iii) D_2 = Booting stage (at 45-54 DAS), iv) D_3 = Anthesis stage (at 55-64 DAS). The experiment was laid out in a completely randomized design (factorial) with three replications. Organic manure showed positive impact on yield and cowdung (O_1) gave the highest grain yield (4.06 g plant^{-1}). This may be attributed to the highest number of effective tillers plant^{-1} (3.21), spike length (9.53 cm), spikelet spike^{-1} (17.31), grains spikelet^{-1} (2.31) and 1000-grain weight (44.61 g) of wheat in this treatment. In respect of drought imposition treatments, grain yield was found higher in control treatment (without imposition of drought) which was statistically similar with drought imposition at booting stage treatment (D_2). These two treatments also showed highest number of effective tillers plant^{-1}, spikelets spike^{-1}, grains spike^{-1} and 1000-grain weight. Regarding the interaction of organic manure and drought, cowdung without drought imposition (O_1D_0) and cowdung with drought imposition at booting stage (O_1D_2) were highest yielder among the other interactions which was attributed to higher 1000-seed weight, number of effective tillers plant^{-1}, spikelets spike^{-1} and grains spike^{-1}. Results revealed that application of organic manure could reduce the impact of drought on wheat irrespective of growth stages. However, application of cowdung (10 t ha^{-1}) was found more effective to combat drought impact at booting stage of wheat compared to other growth stages.

Introduction

Wheat (*Triticum aestivum L*) is the most important cereal crop in the world and it is one of the main sources of carbohydrate and also contains a considerable amount of protein, minerals and vitamins. It has significant role in human nutrition. Drought stress is one of the major abiotic stresses, which adversely affects crop growth and yield. Drought is the most common environmental stress affecting about 32% of the 99 million hectares under wheat cultivation in developing countries and at least 60 million hectares under wheat cultivation in developed countries (Rajaram, 2000). Drought stress reduces plant growth by affecting various physiological and biochemical processes, such as transpiration, translocation, ion uptake and nutrient metabolism (Farooq *et al.*, 2008). Understanding of plant responses to drought stress is of great importance and a fundamental part for making the crops tolerant to stress conditions (Zhao *et al*., 2008). Some studies suggest that drought stress influences the thermal tolerance of photosynthesis (Havaux, 1992). Mirzaei *et al.* (2011) reported that drought stress induced at all growth stages reducing grain yield and yield components. Drought stress at stages of stem elongation, flowering and grain filling stages induced 32, 32 and 35% reduce in grain yield, respectively. Sarwar (2005) also found that grain yield and yield components of wheat significantly increased with the application of different organic materials resulting in the compost to be the most superior one. In addition, Yassen *et al.* (2006) was found that the irrigation at 60% water holding capacity and applying mineral nitrogen 60 kg/fed, with presence of the chicken manure as an organic fertilizer produced the highest wheat yield through two growth seasons. As such, this experiment was designed to determine the effect of water stress at different growth stages of wheat and to combat water stress through application of organic manure.

Materials and Methods

The pot experiment was conducted at the net house of the department of agronomy, Sher-e-Bangla Agricultural University (SAU), Dhaka-1207, during the period of November 2018 to March 2019. The experimental field was located at $23^0 41'$ N latitude and $90^o 22'$ E longitude at a height of 8.6 m above the sea level. The soil of the experimental site was clay loam belonging to the "Madhupur Tract" under AEZ 28. The experiment comprised two factors viz. factor A: Organic manure (O)-3, i) O_0 = Control (Recommended dose of chemical fertilizer/ RDCF + without organic fertilizer), ii) $O_{1\,=}$ RDCF + Cowdung, iii) $O_{2\,=}$ RDCF + Poultry litter, factor B: Comprising drought by removing irrigation- 4 i) D_0 = Control (without drought), ii) D_1 = Crown root initiation stage (at 19-20 DAS), iii) D_2 = Booting stage (at 45-54 DAS), iv) D_3 = Anthesis stage (at 55-64 DAS). The experiment was laid out in a completely randomized design (factorial) with three replications. A total of 36 earthen pots measuring 22 cm diameter and 18 cm height were collected from the local market. Each pot was fill-up with 20 kg of soil. Urea, TSP, MoP, Gypsum, Zinc oxide and Boric acid were used at the rate of 200, 72, 66, 110, 4 and 5 kg ha^{-1} (2.00, 0.72, 0.66, 1.10, 0.04 and 0.05 g pot^{-1}), respectively mixed with the soil before fill-up the pot except urea. Urea was applied in three equal splits at pot filling up, 21 DAS and 55 DAS. Cowdung and poultry litter were applied in the pots @ 10 and 5 t ha^{-1}, respectively as per treatment. Seeds of wheat variety BARI Gom28 were collected from Wheat Research Center, Bangladesh Agriculture Research Institute (BARI) campus, Joydebpur, Gazipur. Before sowing, seeds were treated with Provex 200EC @ 2.5 g powder for kg^{-1} seed. Ten seeds were sown in each pot on 23rd November 2018. After sowing, the seeds were covered with soil and lightly pressed by hand. Five plants were kept for assessment in each pot after 14 DAS. Different intercultural operations were done to ensure normal growth of the crop except irrigation. Irrigation was applied as per need of treatment of the experiment where irrigation was not applied during drought imposition period(s) treatments. The crop was harvested at different dates on the basis of physiological maturity. The crop was harvested on 11 March, 2019. Data on different crop characters, yield attributes and yield were collected from the harvested five plants from each pot. Threshing, cleaning and drying of grains were done separately for each treatment. Properly dried grain and straw were weighed and converted into g $plant^{-1}$ basis. The collected data of each pot were statistically analyzed to obtain the level of significance using the computer-based software Statistics10. Mean difference among the treatments were tested with Duncan's Multiple Range Test (DMRT) test at 5 % level of significance.

Results and Discussion

Significant difference existed among different organic manures with respect to yield and yield contributing characters (Table 1 and Table 2). The yield advantages of 0.45 g and 0.75 g $plant^{-1}$ for O_1 (Cowdung) applied pot over O_2 (poultry litter) and O_0 (no organic manure) applied pot was found possibly aided by higher tillers $plant^{-1}$ (3.21), spike length (9.53cm), spikelets $spike^{-1}$ (17.31), grains $spike^{-1}$ (2.31), weight of 1000-grains (44.61 g), straw yield (4.44 g $plant^{-1}$), biological yield (8.50 g $plant^{-1}$) and harvest index (47.26%) in the O_2 (Cowdung) applied treatment. The result agrees with the findings of Ibrahim *et al.* (2008) and Hammad *et al.* (2011) that organic fertilizer increased wheat yield over control. According to Uyanoz *et al.* (2006) yield attributes of wheat improve with organic manure which corroborates with the present findings.

Table 1. Effect of organic manures on plant height and yield attributes of wheat

Organic manure	**Plant height (cm)**	**Effective tillers plant^{-1} (no.)**	**Spike length (cm)**	**Spikelet Spike^{-1} (no.)**	**Grains spikelet^{-1} (no.)**	**Grains spike^{-1} (no.)**	**Weight of 1000 grains (g)**
O_0	69.105 b	2.02 c	8.34 b	16.18 b	1.94 b	31.01 c	39.69 b
O_1	76.779 a	3.21 a	9.53 a	17.31 a	2.31 a	37.16 a	44.61 a
O_2	70.171 b	2.65 b	8.50 b	16.52 b	1.92 b	32.71 b	40.41 b
SE	2.42	0.14	0.19	0.33	0.06	0.70	0.99
CV (%)	8.23	13.17	5.21	4.90	7.60	5.09	5.86

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 5% level of significance
Here: O_0= Control (Only RDCF + no organic manure), O_1= RDCF + Cowdung, O_2 = RDCF + Poultry litter

Table 2. Effect of organic manure on yields and harvest index of wheat

Organic manure	**Grain yield plant^{-1} (g)**	**Straw yield plant^{-1} (g)**	**Biological yield plant^{-1} (g)**	**Harvest index (%)**
O_0	3.31 c	3.73 c	7.04 c	46.66
O_1	4.06 a	4.44 a	8.50 a	47.26
O_2	3.56 b	4.05 b	7.61 b	46.51
SE	**0.0819**	**0.776**	**0.1526**	**NS**
CV (%)	**5.51**	**4.67**	**4.85**	**3.75**

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 5% level of significance
Here: O_0= Control (Only RDCF+ no organic manure), O_1= RDCF + Cowdung, O_2 = RDCF + Poultry litter

The result reveled that among the drought imposed treatments, the control plants D_0 (without drought) and D_2 (drought imposition at booting stage, 45-54 DAS) showed highest and statistically similar grain yield, effective tillers hill^{-1}, spikelet spike^{-1}, grains spike^{-1}, weight of 1000 gains and harvest index (Table 3 and Table 4). D_0 (without drought) treatment was out yielded by producing 28.99% and 65.78% higher yield over D_1 (drought imposition at crown root initiation stage) and D_3 (drought imposition at anthesis stage), respectively. On the other hand, D_2 (drought imposition at booting stage) treatment was out yielded by producing 23.96% and 59.32% higher yield over D_1 (drought imposition at crown root initiation stage) and D_3 (drought imposition at anthesis stage), respectively. The treatment D_0 (without drought) also produced highest level of tillers plant^{-1}, spikelets spike^{-1}, grains spike^{-1}, straw yield, biological yield and harvest index than drought imposition plants. However, among the drought imposition treatments D_2 (drought at booting stage) gave highest yield and yield attributes than other drought imposition treatments. The present result was supported by the findings of Akram (2011) that drought imposition at different growth stages caused severe reduction in yield and yield components of wheat. Similar result was also observed by Alghabari and Isham, (2018) that drought stress affected barley yield through impaired grain development and grain filling duration.

Table 3. Effect of drought stress on plant height and yield attributes of wheat

Drought stage	Plant height (cm)	Effective tillers (no.)	Spike length (cm)	Spikelet Spike^{-1} (no.)	Grains Spikelet^{-1} (no.)	Grains Spike^{-1} (no.)	Weight of 1000 grain (g)
D_0	76.02 a	2.93 a	9.82 a	17.94 a	2.29 a	36.70 a	44.82 a
D_1	69.82 bc	2.47 bc	8.40 c	16.00 b	1.95 b	32.16 b	40.33 b
D_2	74.73 ab	2.75 ab	9.11 b	17.62 a	2.16 a	35.26 a	43.10 a
D_3	67.50 c	2.36 c	7.83 d	15.10 c	1.83 b	30.40 c	38.05 b
SE	2.7952	0.1630	0.2161	0.3852	0.0737	0.8072	1.14.76
CV (%)	8.23	13.17	5.21	4.90	7.60	5.09	5.86

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 5% level of significance
Here: D_0 = Control (No stress), D_1= Crown root initiation stage (20-19 DAS), D_2 = Booting stage (45-54 DAS) and D_3= Anthesis stage (55-64 DAS)

Table 4. Effect of drought stress on yields and harvest index of wheat

Drought stage	Grain yield plant^{-1} (g)	Straw yield plant^{-1} (g)	Biological yield plant^{-1} (g)	Harvest index (%)
D_0	4.36 a	4.70 a	9.06 a	48.10 a
D_1	3.38 b	3.89 c	7.27 c	46.29 b
D_2	4.19 a	4.43b	8.62 b	48.27 a
D_3	2.63 c	3.26d	5.90 d	44.59 b
SE	0.0946	0.0896	0.1762	0.8268
CV (%)	5.51	4.67	4.85	3.75

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 5% level of significance
Here: D_0 = Control (No stress), D_1= Crown root initiation stage (20-19 DAS), D_2 = Booting stage (45-54 DAS) and D_3= Anthesis stage (55-64 DAS)

Interaction of organic manure and drought stress treatment showed significant variation in all the studied parameters in this experiment (Table 5 and Table 6). The interaction of O_1D_0 (Cowdung × without drought treatment) and O_1D_2 (Cowdung × drought at booting stage) performed best in respect of grain yield (4.72 and 4.55 g plant^{-1}, respectively) which may be attributed to highest effective tillers plant^{-1}, spike length, spikelet spike^{1}, grains spikelet^{1} and weight of 1000-grain in these interactions.

Table 5. Interaction effects of organic manure and drought stress on plant height and yield contributing characters of wheat

Interaction (Organic manu. × Drou.)	Plant height (cm)	Effective tillers plant^{-1} (no.)	Spike length (cm)	Spike let spike^{-1} (no.)	Grains spikelet^{-1} (no.)	Grains spike^{-1} (no.)	Weight of 1000-grains (g)
O_0D_0	70.76 a-d	2.21 e	9.44 bc	17.18 bc	2.15 bc	34.09 bc	45.14 a-c
O_0D_1	68.40 b-d	1.88 e	7.87 f-h	15.61 d-f	1.82 ef	29.56 ef	37.76 fg
O_0D_2	71.53 a-d	2.10 e	8.77 c-e	17.61 ab	1.87 de	32.22 c-e	41.91 b-e
O_0D_3	65.73 cd	1.87 e	7.27 h	14.29 f	1.93 c-e	28.19 f	33.97 g
O_1D_0	79.83 a	3.48 a	10.79 a	18.91 a	2.51 a	40.02 a	46.99 a
O_1D_1	75.47 a-c	3.12 ab	9.08 b-d	16.56 b-d	2.13 b-d	35.83 b	43.28 a-d
O_1D_2	78.72 a-d	3.32 ab	9.72 b	17.72 ab	2.63 a	39.02 a	45.93 ab

O_1D_3	73.10 a-d	2.95 a-c	8.54 d-f	16.03 c-e	1.99 b-e	33.78 b-d	42.25 b-d
O_2D_0	77.47 ab	3.10 ab	9.22 b-d	17.73 ab	2.20 b	36.00 b	42.32 b-d
O_2D_1	65.60 cd	2.40 c-e	8.24 e-g	15.83 c-e	1.91 c-e	31.08 d-f	39.95 d-f
O_2D_2	73.95 a-c	2.83 b-d	8.84 c-e	17.53 ab	1.98 b-e	34.53 bc	41.46 c-f
O_2D_3	63.67 d	2.26 de	7.69 gh	14.97 ef	1.57 f	29.22 f	37.92 e-g
SE	4.84	0.28	0.37	0.66	0.12	1.39	1.98
CV (%)	8.23	13.17	5.21	4.90	7.60	5.09	5.86

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 5% level of significance

Here: O_0= Control (Only RDCF+ no organic manure), O_1= RDCF + Cowdung, O_2 = RDCF + Poultry, D_0 = Control (No stress), D_1= Crown root initiation stage (20-19 DAS), D_2 = Booting stage (45-54 DAS) and D_3= Anthesis stage (55-64 DAS)

Table 6. Interaction effects of organic manures and drought stress on yields and harvest index of wheat

Interaction (Organic manure × Drought)	**Grain yield plant^{-1} (g)**	**Straw yield plant^{-1} (g)**	**Biological yield plant^{-1} (g)**	**Harvest index (%)**
O_0D_0	4.07 cd	4.48 c	8.55 c	47.52 a-d
O_0D_1	2.78 fg	3.40 ef	6.18 ef	45.00 d-f
O_0D_2	3.91 d	3.86 d	7.77 d	50.32 a
O_0D_3	2.47 g	3.16 f	5.63 f	43.80 f
O_1D_0	4.72 a	4.96 a	9.69 a	48.75 ab
O_1D_1	4.00 cd	4.41 c	8.41	47.47 a-d
O_1D_2	4.55 ab	4.87 ab	9.42 ab	47.10 b-e
O_1D_3	2.96 f	3.51 e	6.47 e	45.72 c-f
O_2D_0	4.30 bc	4.65 a-c	8.95 bc	48.02 a-c
O_2D_1	3.35 e	3.87 d	7.22 d	46.39 b-f
O_2D_2	4.10 cd	4.56 bc	8.66 c	47.38 a-d
O_2D_3	2.47 g	3.12 f	5.59 f	44.24 ef
SE+	0.16	0.15	0.30	1.43
CV (%)	5.51	4.67	4.85	3.75

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 5% level of significance

Here: O_0= Control (Only RDCF+ no organic manure), O_1= RDCF + Cowdung, O_2 = RDCF + Poultry, D_0 = Control (No stress), D_1= Crown root initiation stage (20-19 DAS), D_2 = Booting stage (45-54 DAS) and D_3= Anthesis stage (55-64 DAS)

Conclusion

It may be concluded from the result that, application of cowdung (10 t ha^{-1}) seems promising to overcome yield loss due to drought stress at booting stage of wheat.

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