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Effect of Vermicompost and Organic Matter in Enhancing Wheat Tolerance against Drought Stress

Shair Ahmad[1*], Atiq ur Rehman Aziz[1*], Asad Ullah[1] and Muhammad Ali Raza[1]

[1]Plant Breeding and Genetics, University of Agriculture Faisalabad, Pakistan
***Corresponding author:** stepahmad01@gmail.com; atiq9119@gmail.com

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ABSTRACT

An experiment was conducted during rabi season of 2021-2022 at the Agronomy Research Farm, Department of Agronomy, Faculty of Agriculture, University of Agriculture, Faisalabad, Punjab, Pakistan, to study the appropriate dosage of Organic matter and vermicompost for wheat germination and growth under drought conditions. The experiment was laid out in a randomized complete block design (RCBD) with twelve treatments (1) clay Soil at 100% field capacity (F.C) (T1: control, T2: V.C@ 5g/2kg of soil, T3: O.M@15g/2kg of soil), (2) sandy soil at 100% F.C (T4: control, T5: V.C@ 5g/2kg of soil, T6: O.M@15g/2kg of soil), (3) clay soil at 50% F.C (T7: Control, T8: V.C@ 5g/2kg of soil, T9: O.M@15g/2kg of soil), (4) sandy Soil at 50% F.C (T10: control, T11: V.C@ 5g/2kg of soil, T12: O.M@15g/2kg of soil), and replicated three times. Results indicate that the growth parameters, clay soil at 50% F.C and sandy soil at 100% F.C have (109.34 t/ha) found highest in combined application of organic matter@15g/2kg + vermicompost @5g/2kg.

Key words: Drought stress, Vermicompost, Organic matter, Wheat, Tolerance, Germination

INTRODUCTION

Wheat (*Triticum aestivum)* is staple food and one of the main crops of Pakistan (Bashir *et al*., 2022). It is sown on area of 9 lac hectares with production of 27 million tones. With constantly increasing population, despite of increase in the production of wheat in country, the need and demand of wheat is increasing day by day. However, wheat has higher yield potential, but different environmental stresses like drought, water excess, heat, salinity and cold affects its growth and in return decreases its yield (Ahmad and Hussain, 2022). Among these stresses, drought stress is major constraint in reduction of wheat yield. The plant suffers from the drought stress when the loss of water from the plant by transpiration through the leaves surface exceeds the water uptake by the plant through roots (Haroon *et al*., 2022).

Vermicompost increases the microbial activity in the soil, increases the soil productivity, makes soil more porous and increases the availability of oxygen and improves the quality and quantity of plant growth (Blouin *et al*., 2019). The recent research showed on vermicompost, the importance of earthworms. They increase the microbial activity in the soil. In present times, heavy doses of synthetic fertilizers are used by farmers for getting higher yield, but these synthetic fertilizers decrease the soil fertility, causes effects on both environment and human health (Benaffari *et al*., 2022). By considering the above affects many scientists showed the interest towards the organic cultivation by using manures and vermicompost. Vermicompost and organic matter (O.M) contents in the soil are an excellent amendment and source of nutrients for main fields and nursery beds of crops (Feizabadi *et al*., 2021). Role of vermicompost in nourishing agricultural crops has attracted the attention of researchers throughout the globe in past few decades. In Pakistan, 2020, wheat production for Pakistan was 24,946 thousand tones. Higher yield and profit motivate the farmers to grow wheat. The vermicompost treatment increase the fresh weight, plant number, shoot and root weight than the control treatment respectively (Ahmad *et al.*, 2022). By application of organic matter and vermicompost there was a significant improvement in plant growth and morphology (higher number of leaves and leaf area, and increased root volume and branching) of wheat plant. Organic manure has been widely used as it is available at low-cost and it improves crop plants characteristics compared with synthetic fertilizer (Bairagya, 2019; Lazcano *et al.*, 2009). Application of vermi-compost can improve soil organic carbon, nitrates, phosphates and exchangeable bases for plants.

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Table 1: Fresh weight of Wheat Plant; Application of Vermicompost and Organic matter

Plant Fresh Weight (g)									
			R1	R2	R3	Mean	SD	SE	CV
100% Field Capacity	Control	T0	9	8	12	9.67	2.08	1.20	21.53
	Vermi-compost	T4	12	8	12	9.67	2.08	1.20	21.53
	Organic Matter	T8	12	11	11	11.33	0.58	0.33	5.09
		Clay Soil							
50% Field Capacity	Control	T1	10	9	11	10.0	1.00	0.58	15.80
	Vermi-compost	T5	14	12	11	12.33	1,53	0.88	12.39
	Organic Matter	T9	14	11	14	13.00	1.73	1.00	13.32
	Control	T2	9	11	12	10.67	1.53	0.88	24.12
	Vermi- compost	T6	9	10	7	8.67	1.53	0.88	17.63
	Organic Matter	T10	5	4	3	4.00	1.00	0.58	25.00
		Sandy Soil							
	Control	T3	5	8	6	6.33	1.53	0.88	24.12
	Vermi- compost	T7	5	7	8	6.67	1.53	0.88	22.91
	Organic matter	T11	3	3.5	4	3.50	0.50	0.29	14.29

Table 2: Root Length of Wheat Plant

Root Length(cm)									
			R1	R2	R3	Mean	SD	SE	CV
100% Field Capacity	Control	T0	43	40	42	41.67	1.53	0.88	2.12
	Vermi-compost	T4	44	44	46	44.67	1.15	0.67	1.49
	Organic Matter	T8	38	36	39	37.67	1.53	0.88	2.34
		Clay Soil							
50% Field Capacity	Control	T1	39	40.5	38	39.	1.26	0.73	1.86
	Vermi-compost	T5	51.5	48	50	49.83	1.76	1.01	2.04
	Organic Matter	T9	48	45	49	47.33	2.08	1.20	2.54
	Control	T2	49.5	50	52	50.50	1.32	0.76	1.51
	Vermi- compost	T6	58	56	56.5	56.83	1.04	0.60	1.60
	Organic Matter	T10	44	41.5	46	43.83	2.25	1.30	2.97
		Sandy Soil							
	Control	T3	27	25	28	26.67	1.53	0.88	3.31
	Vermi- compost	T7	40	39.7	41.5	40.40	0.96	0.56	1.38
	Organic matter	T11	24.5	21	23	22.83	1.76	1.01	4.45

Table 3: Shoot Length of Wheat Plant

Shoot Length(cm)									
			R1	R2	R3	Mean	SD	SE	CV
100% Field Capacity	Control	T0	30	28.5	28	28.83	1.04	0.60	2.09
	Vermi-compost	T4	24.3	26	25.5	25.33	0.76	0.44	1.76
	Organic Matter	T8	23.5	25	23,5	24.00	0.87	0.50	2.09
		Clay Soil							
	Control	T1	28	27.5	26	27.30	1.13	0.65	2.39
50% Field Capacity	Vermi-compost	T5	31.5	30	29	30.17	1.26	0.73	2.41
	Organic Matter	T9	29	28.3	27	28.10	1.01	0.59	2.09
	Control	T2	18	19.2	17.4	18.20	0.92	0.53	2.91
	Vermi- compost	T6	29	30.4	29.5	29.63	0.71	0.41	1.38
	Organic Matter	T10	21	22.2	24	22.40	1.51	0.87	3.90
		Sandy Soil							
	Control	T3	21	20.6	19	20.20	1.06	0.61	2.03
	Vermi- compost	T7	23	24.5	22	23.17	1.26	0.73	3.14
	Organic matter	T11	16	17.3	16.5	16.60	0.66	0.38	2.28

MATERIALS AND METHODS

Site and Treatments Description

Two sets of experiments were performed at agronomy farm, University of Agriculture (UAF) on 02-11-2021. As it was a pot experiment, each pot weighted 100g. There was total 36 pots. Total 12 treatments were given and each treatment had three replications. There were two main divisions of soil type: sandy and clay loam.

Soil for experiment was collected from different fields at agronomy farm. Two kg soil was added per pot, then organic matter and vermicompost was mixed in this soil. The recommended and calculated dose of organic matter and vermicompost was 7.5g and 2.5g per kg respectively. Two types of field capacity were maintained for experiment: 50% and 100%.

The first set of experiment was consisting of pots with sandy soil. Pots with sandy soil and 100% FC under control conditions had total weight of 2380g, having net weight of 100g(pot), 2000g of soil and 280ml of water. And pot with 50% FC had total weight of 2240, having net weight of 100g (pot), 2000g of soil and 140ml of water. Each pot in this set containing O.M and V.C had an additional weight of 15 and 5g in total. The second set of experiment consists of clay loam pots. Pots with clay loam soil and 100% F.C. under control conditions had total weight of 2540g, having net weight of 100g (pot), 2000g of soil and 440ml of water. And pot with 50% F.C. had total weight of 2320, having net weight of 100g (pot), 2000g of soil and 220ml of water. Each pot in this set containing O.M and V.C had an additional weight of 15g and 5g respectively.

As the whole experiment was based on F.C. so our main objective was to maintain FC on daily basis. The average water required to maintain 100% F.C. in sandy soil under control conditions was 50ml/pot,14ml/pot in pot having V.C. and 27ml/pot in pot having Organic Matter plus Sandy soil.

The average water required to maintain 100% FC in clay soil under control conditions was 40ml/pot, 9ml/pot in pot having V.C and 20ml/pot in pot having Organic Matter plus Clay soil. The average water required to maintain 50% FC in sandy soil under control conditions was 25ml/pot, 7ml/pot in pot having V.C. and 13ml/pot in pot having Organic Matter plus Sandy soil.

The average water required to maintain 50% F.C. in clay soil under control conditions was 20ml/pot, 4ml/pot in pot having V.C and 10ml/pot in pot having Organic Matter plus clay soil. In sandy soil overall wheat growth was not good but roots growth was high or very well comparatively in Clay soil. No. of tillers formation and shoot length was short in sandy soil comparatively in clay soil. Tip of wheat in sandy soil was yellow

RESULTS AND DISCUSSION

The current study assessed wheat performance for morphological traits involved in normal plant growth and production under drought stress conditions when vermicompost and organic manure was applied. Drought stress had a considerable negative impact on the wheat crop's performance when compared to the control, mostly through the generation of reactive oxygen species (ROS), which changed the leaf water potential, led to protein denaturation, and eventually impacted crop yield (Farooq *et al*., 2021). Due to a substantial reduction in cell turgidity and protoplasmic dehydration, prolonged drought also slows down plant development and crop yield. Our findings demonstrated that the use of vermicompost under drought stress greatly increased wheat morphological, physiological and enzymatic antioxidant activity. Vermicompost increases the availability of nutrient that are essential for plant growth. The application of vermicompost shows the great response and plant growth increases effectively. The significant increase in plant height was observed by the application of vermicompost under the 50 percent field capacity in clay soil. Plant root and shoot length revealed noticeable increment due to vermicompost. The sandy soil with 100 percent field capacity shows the best results after application of vermicompost in the sandy soil. The plant fresh weight (as shown in Table 1) indicates the better utilization of nutrient in the presence of vermicompost as compared to organic matter. The plant root-shoot length is also more in 50 percent field capacity in the clay soil and 100 percent field capacity in the sandy soil (Table 2 and 3). The variation in the plant height indicates that the application of vermicompost is more effective in the drought conditions as compared to organic matter. The plant shoot length is less in the presence of organic matter (as shown in Table 3). Similar results for root and shoot length were reported by (Ahmad *et al*., 2022; Jindo *et al*., 2016).

Conclusion

Soil-applied vermicomposting and organic manure are practical methods to alleviate wheat drought damage. Vermicompost application, especially at a high rate, significantly boosted the growth and of studied genotypes in response to drought stress. Thus, wheat genotypes promote superior development under drought stress by application of vermicomposting and organic manure.

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