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EFFECT OF POTASSIUM NITRATE AND BLACK TEA LEAF WASTE ON THE CHEMICAL COMPOSITION OF WHEAT (*TRITICUM AESTIVUM* L.)

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SUMMARY

The presented study sought to determine the foliar application of potassium nitrate effects and addition of black tea leaf wastage to soil on the biochemical qualities (zinc, protein, oil percentage, and carbohydrate) of wheat (*Triticum aestivum* L.) and the content of NH_4N, Na, Mg, Ca, Cl, and pH of the soil. The pot experiment commenced in the spring of 2022 in a randomized complete block design (RCBD) with a factorial arrangement having two factors and four replications in Al-Hindia city, Kerbala, Iraq. The first factor was a potassium nitrate compound comprising three levels (control, 1000, and 3000 g 1000 l^{-1}), and the second factor was black tea leaf waste mixed with soil in four doses (control, 25, 45, and 55 g 1000 l^{-1}). The results showed the impact of black tea wastes mixed with the soil of higher significance, increasing the NH_4N, Na, Mg, Ca, and Cl to 29.28 mg kg^{-1}, 3.75, 3.88, 5.88, and 6.79 mm l^{-1}, respectively, and higher impact in reducing the soil pH (7.54) at a concentration of 55 g 1000 l^{-1}). The black tea leaf waste (55 g 1000 l^{-1}) helped raise the treated wheat's zinc, protein, oil, and carbohydrate percentages. The foliar application of potassium nitrate compound (3000 g 1000 l^{-1}) considerably affected increasing the proportion of zinc, protein, and oil in wheat grains.

Keywords: *Triticum aestivum* L., potassium nitrate, black tea leaf waste, zinc, protein, oil percentage, carbohydrates

Key findings: Black tea wastes mixed with high-quality soil increased the NH_4N, Na, Mg, Ca, and Cl of the soil to 29.28 mg kg^{-1}, 3.75, 3.88, 5.88, and 6.79 mm l^{-1}, respectively, and highly impacted reducing the soil pH (7.54) at a concentration of 55 g 1000 l^{-1}). Black tea leaf waste (55 g 1000 l^{-1}) also boosted the wheat's zinc, protein, oil, and carbohydrate content. The potassium nitrate compound (3000 g 1000 l^{-1}) foliar application increased wheat grain's zinc, protein, and oil concentrations.

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INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the valuable cereal crops in Iraq, and it ranks first based on cultivated area and production. Iraq has the leading suitable environment for sustainable wheat production compared with its neighboring countries. However, based on the available cultivated area, its productivity is below the required level, as Iraq only produces 6.03 million tons of wheat grains, and its consumption is around 5.04 million tons of imported wheat grains (Farhood *et al*., 2020; CSO, 2022). Mineral fertilizers are vital in modern agriculture to reduce crop plants' deficiency of macro- and micro-nutrients in the soil to enhance their productivity (Ramzan *et al*., 2023).

However, the continuous overdose usage of chemical fertilizers causes significant damage to the soil and the environment, as well as toxicity to humans and animals. Therefore, an alternative in the form of natural organic compost, such as plant and animal residues, can replace mineral fertilizers. Natural organic compost can improve the soil's structure, composition, and chemical properties, and its ability to absorb and retain moisture for a long time is harmless for the environment, vegetation, and soil. Domestic tea, which is a popular drink used by more than half of the population, its wastes can benefit as important active chemical compounds (Khalid, 2018).

Fertilizers are natural and synthetic materials that provide crop plants with macro- and micro-nutrients necessary for their growth, development, and enhanced production. Based on their source of production, fertilizer classification has two main categories, i.e., organic (natural) and chemical (industrial). Natural fertilizers include animal and plant wastes, while chemical fertilizers come from mineral and chemical materials in specialized factories (Liu, 2014).

Using organic fertilizers and municipal waste has numerous positive effects on crop plant growth and chemical composition in deteriorated soils (Albaladejo *et al*., 1994). Numerous past studies have confirmed the role of soil organic matter as a source of macro- and micro-nutrients for crop plants and the effect of their decomposition products on boosting the readiness of elements and their role in binding the soil particles (Al-Bayati and Al-Anizy, 2017). Several undiscovered substances have shown one of the most significant recent developments is an increased use of medicinal plants for several plant species' germination, growth, and nutrition (Hussein, 2002).

Black tea contains active chemical compounds like the aflavin, 3-gallate aflavin, flavin's astringent flavor, and copper resulting from the orange-red aflavin component. Past studies have also established the antioxidant effects of tea polyphenols (Chan *et al*., 2011). Mixing tea with soil increases soil fertility and moisture storage, causing a series of chemical alterations in enzyme degradation, oxidation, enzyme oxides, and phenol (Chen *et al*., 1992). Tea contains various chemical compounds, phenols, proteins, and oxidation enzymes crucial for metabolites. The findings of Wafik *et al*. (2011) revealed that tea waste mixing with soil increased the growth and seed yield of *Vigna radiata*.

Foliar application of nutrients provides the foundation for photosynthesis and other essential physiological processes to fulfill the nutrient deficiency in these specialized parts of crop plants to improve their growth, development, and, eventually, yield (Mohammed *et al.,* 2021). The nutrients added to the soil lower soil losses to shield it from washing, volatilization, and sedimentation to solve the problems related to unavailable nutrients and provide a better uniform distribution of nutrients in the vegetative system (Hassan, 1988). Potassium is one of the essential nutrients needed by plants. The chief positive and defining characteristic of potassium is its existence as a free ion, not entering into the formation of any organic plant compound (Havlin *et al*., 2005). It supports regulating moisture balance in plant tissues, leaf movement, and different tropes and maintaining cell turgor (Chaves *et al*., 2005).

Potassium works to regulate the transpiration process in the plant through its role in regulating the opening and closing of stomata (Smail *et al.,* 2004). Al-Jahabi *et al*.

(2006) revealed that applying potassium (3000 mg l^{-1}) enhanced the percentage of dry matter in wheat crops. Adding potassium to the soil compost and its spraying has increased the *Zea mays* grains' protein and phosphorus content (Al-Musawi, 2010). The presented study sought to determine the effects of foliar application of potassium nitrate compound and adding black tea leaf waste to the soil on the chemical properties (zinc, protein, and oil percentage) of wheat (*Triticum aestivum* L.) and the soil's chemical contents (NH_4N, Na, Mg, Ca, Cl, and pH).

MATERIALS AND METHODS

The promising research sought to determine the effects of black tea residues on the chemical properties of wheat and soil. The laid-out pot experiment in the spring of 2022 had a randomized complete block design (RCBD), with a factorial arrangement of two factors and four replications in Al-Hindia city, Kerbala, Iraq. The first factor was potassium nitrate compound comprising three levels (control, 1000, and 3000 g 1000 l^{-1}), and the second factor was black tea leaf wastes mixed with soil at four different doses (control, 25, 45, and 55 g 1000 l^{-1}).

The medicines' administration comprised two dosages, and after monitoring all growth indicators, the harvest of the plants ensued at full maturity.

Preparation of potassium nitrate compound

Based on concentrations of potassium nitrate compound (1000 and 3000 g 1000 l^{-1}), adding the 1000 and 3000 g of potassium to 1000 L of distilled water proceeded, respectively.

Preparation of black tea waste

Based on black tea waste concentrations (25, 45, and 55 g 1000 l^{-1}), the 25, 45, and 55 g of black tea wastes incurred mixing with 1000 L of distilled water, respectively.

Soil preparation

The blended soil samples, collected from Alhindia city, Kerbala, Iraq, reached packing in plastic pots with a 30 cm diameter and a 45 cm height, having 10 kg of soil per pot. Specific characteristics bore assessment, with the hydrometer approach describing the soil chemistry. Soil samples coming deep from the ground sustained analysis at the Laboratory of the Department of Agriculture, Kerbala, before conducting the wheat experiment to determine their physical and chemical properties (Page *et al.*, 1982). Chemical analyses of soil before and after adding the black tea wastes are in Tables 1 and 2.

Table 1. Chemical analysis of soil before adding black tea leaf waste.

Chemical qualities	Values
pH	7.19
Na	1.69 mm l^{-1}
Ca	3.56 mm l^{-1}
Cl	3.31 mm l^{-1}
Mg	1.33 mm l^{-1}
NH_4N	24.38 mg kg $^{-1}$

Table 2. Chemical analysis of soil after mixing with black tea leaf waste.

Control	NH_4N (mg kg^{-1})	Na (mm l^{-1})	Mg (mm l^{-1})	Ca (mm l^{-1})	Cl (mm l^{-1})	pH
	26.71	2.55	2.45	4.65	5.77	7.92
25 (g 1000 l^{-1})	27.31	2.88	2.94	4.70	5.89	7.79
45 (g 1000 l^{-1})	28.65	3.21	3.51	5.32	6.54	7.68
55 (g 1000 l^{-1})	29.28	3.75	3.88	5.88	6.79	7.54
$LSD_{0.05}$	0.123	0.125	0.176	1.36	0.174	0.164

Chemical qualities

Oil percentage

Using a Soxhlet apparatus, placing 100 g of plant powder in a thimble with 300 ml of ether alcohol (80%) in a round flask with a volume of 500 ml helped extraction for 24 h. Evaporating the extract used an evaporation apparatus at 45 °C (Al-Ibrahemi *et al*., 2022).

Protein percentage

Using a Kjeldahl apparatus continued to estimate protein in the laboratories at the Department of Agriculture, the Holy Kerbala, affiliated with the Iraqi Ministry of Agriculture (Bremner, 1965).

Zinc percentage

Determining the zinc content in seeds had 2.0 g of pulverized seeds digested in a solution of sulfuric and chloric acids before measuring with an adsorbent metric atomic spectrophotometer.

Carbohydrate percentage

In wheat seeds, the carbohydrates estimations in each transaction were as follows (Herbert *et al*., 1971): A gram of dry matter placed in a chord with 5 ml distilled water bore crushing well, added to the material in the ceramic injection with another 5 ml of distilled water, and then transported to a test tube, placing the test tube inside the centrifuge for 5 min at 1500 cycle min^{-1}, and by taking one ml from the upper layer of the tube and adding one ml to the phenol screen at a concentration of 5% and 1 ml sulfuric acid of the mixture for 30 min, then examined along the wave at 490.

Statistical analysis

Data analysis used the statistical application Genstat to determine the differences according to RCBD with two factors. Using the $LSD_{0.05}$ test compared the means differences (Al-Rawi and Khalaf-Allah, 1980).

RESULTS AND DISCUSSION

Chemical analyses of the soil after mixing with black tea wastes focused on the significant impact of the black tea wastes (Table 2). The addition of three levels of black tea wastes (25, 45, and 55 g 1000 l^{-1} of distilled water) to the soil significantly increased the chemical properties of soil, i.e., NH_4N in soil (26.71 mg kg in control) increased to 27.31, 28.65, and 29.28 mg kg, respectively. The Na (2.55 mm l^{-1} in control) considerably improved to 2.88, 3.21, and 3.75 mm l^{-1}, while Mg (2.45 mm l^{-1} in control) also increased to 2.94, 3.51, and 3.88 mm l^{-1}, respectively. The Ca in soil (4.65 mm l^{-1} in control) also rose to 4.7, 5.32, and 5.88 mm l^{-1}, respectively, and Cl (5.77 mm l^{-1} in control) soared to 5.89, 6.54, and 6.79 mm l^{-1}, respectively. The black tea leaf waste addition with three different levels (25, 45, and 55 g 1000 l^{-1} of distilled water) has shown a better impact in reducing the soil pH (7.92 in control) to 7.79, 7.68, and 7.54, respectively.

The black tea wastes (with varied content of chemical elements) mixing with soil played a vital role in increasing the soil porosity and speeding up the washing of salts from the soil. These results were consistent with the findings of Abdulghani (2012), who pointed out that municipal solid waste containing tea waste contributes significantly to leaching salts quickly from the soil. It also referred to the higher significance of the black tea wastes with different levels (25, 45, and 55 g 1000 l^{-1}) in reducing the soil pH (7.92 in control) to 7.79, 7.68, and 7.54, respectively. The organic functions played by black tea wastes in the composition of acidic compounds brought on by the simple decomposition of tea and sufficient moisture may have lowered the soil pH (Ozdemir *et al*., 2009).

The potassium nitrate compound (at the rate of 3000 g 1000 l^{-1}) foliar application showed significant variation and gave the highest protein percentage (15.99%) compared with the control (10.13%) (Table 3). The reason for an increased percentage of protein indicates that potassium is crucial in activating the different enzymes. Nitrate also plays an essential process in reducing nitrates

Table 3. Effect of foliar application of potassium nitrate compound and black tea leaf waste and their interaction on protein in wheat grains.

Potassium nitrate (g 1000 l^{-1})	Black tea leaf waste (g 1000 l^{-1})				Means (%)
	Control	25	45	55	
Control	8.51	9.52	10.73	11.76	10.13
1000	10.29	12.71	13.83	15.28	13.02
3000	14.67	15.73	16.28	17.27	15.99
Means (%)	11.16	12.65	13.61	14.77	

$LSD_{0.05}$ Potassium nitrate 0.54, Black tea leaf waste = 0.37, Interaction = 1.43

Table 4. Effect of foliar application of potassium nitrate compound and black tea leaf waste and their interaction on oil content in wheat grains.

Potassium nitrate (g 1000 l^{-1})	Black tea leaf waste (g 1000 l^{-1})				Means (%)
	Control	25	45	55	
Control	41.42	42.56	43.34	46.97	43.82
1000	43.99	45.38	48.95	49.56	46.72
3000	49.65	51.83	55.76	56.34	52.78
Means (%)	45.02	46.59	49.35	50.96	

$LSD_{0.05}$ Potassium nitrate 0.88, Black tea leaf waste = 0.94, Interaction = 1.47

inside the plants and, thus, converting them to 3NH, which in turn has an association with nitrates and a ketone organic acid to form the amino acids, the building blocks of the proteins, and increasing the percentage of nitrogen in wheat grains (Abu-Dahi and Kazem, 2005). These results were analogous to the findings of Abboud and Abbas (2013), who indicated that fertilization with potassium led to an increased protein content in wheat grains. It might be due to the potassium improving the biological processes within the plant and, thus, encouraging the uptake of N and its effects inside plant cells, boosting the plant's ability to benefit from various macro- and micro-nutrients.

Results further revealed the observable changes in handling the black tea waste. The black tea leaf waste concentration (25, 45, and 55 g 1000 l^{-1}) was favorable by providing the highest value of protein percentage in wheat grains (12.65%, 13.61%, and 14.77%, respectively) compared with the protein value in the control wheat grains, which was lowest (11.16%). Mixing black tea waste with soil also helped raise soil fertility and aeration (Table 3). With increased humidity, a series of chemical changes occurred, including enzymatic decomposition and oxidation, especially the enzyme activity of polyphenol oxidase (Abd-al-Rasoul *et al*., 2013).

The wheat variants using potassium nitrate (3000 g 1000 l^{-1}) in interaction with the black tea leaf waste (55 g 1000 l^{-1}) therapy compared with the control treatment revealed significant variations for protein content in the interaction between potassium nitrate and black tea waste, giving the maximum protein value (17.27%) compared with the control treatment (8.51%) (Table 3). The increase in nutrients and macro- and micro-nutrient elements in soil with the above inputs has also improved soil qualities used for wheat (*Triticum aestivum* L.) crops (AL-Ibrahemi and AL-Musawi, 2018).

The potassium nitrate (3000 g 1000 l^{-1}) foliar application showed substantial variation among the wheat variants, providing the highest oil percentage in wheat grains (52.78%) compared with the control treatment (43.82%) (Table 4). An explanation can be because of the positive effect of potassium in increasing the oil percentage in different parts of the plant and its role in encouraging vegetative growth and the root system, thus increasing volatile oil value (Al-Musawi, 2010).

Results further revealed that black tea leaf waste concentrations (25, 45, and 55 g 1000 l^{-1}) were preferable in providing the highest values in the oil percentage (46.59%, 49.35%, and 50.96%) compared with the lowest value in the control therapy (45.02%). Black tea waste significantly affected the oil value because tea contains active chemical compounds, especially volatile oils, containing several amino acids and vitamins. Tea leaves also contain 25%–35% phenols, proteins, and antioxidants, which support various metabolites (Verma and Verma, 2000; Ozdemir *et al*., 2009).

Treatments using potassium nitrate (3000 g 1000 l^{-1}) in interaction with black tea waste (55 g/L) revealed a relevant variation, recording the highest oil value (56.34%), with the lowest value emerging in the interaction of both control treatments (41.42%) (Table 4). The increase in soil's macro- and micro-nutrient elements also has improved soil qualities (Al-Ibrahemi and Al-Musawi, 2018).

Potassium nitrate foliar application (3000 g 1000 l^{-1}) showed considerable variations in the different wheat variants, revealing the highest percentage of zinc (38.05%) compared with the wheat control treatment (33.47%) (Table 5). Potassium nitrate interferes with physiological processes, such as transporting and storing metabolites and water relationships within the plant, promoting nutrient absorption (Armengaud *et al*., 2004).

Considerable variations were evident in wheat variants by treating with potassium nitrate (3000 and 1000 g 1000 l^{-1}), and the highest percentage of carbohydrate percentage (19.92%) appeared with potassium at the rate of 3000 g 1000 l^{-1}, followed by 17.11% with potassium treatment at a rate of 1000 g 1000 l^{-1} and 14.81% (control treatment) (Table 6). It can be attributable to the positive effect of potassium on increasing vegetative capacity to absorb carbohydrates in different plant forms. Its role in promoting foliage growth and increasing the size of the radical has eventually enhanced plant growth. Increased absorption of carbohydrates and the positive overlap between carbohydrates and potassium also prevailed in carbohydrates (Sherchand and Paulsen, 1985).

Tea contains active chemical compounds, especially volatile oils, and several safe acids and vitamins, such as K, B2, C, B1, and A. Tea leaves also contain 25%–35% phenolic compounds, proteins, and antioxidants critical for various metabolic

Table 5. Effect of foliar application of potassium nitrate compound and black tea leaf waste and their interaction on zinc in wheat grains.

Potassium nitrate (g 1000 l^{-1})	Black tea leaf waste (g 1000 l^{-1})				Means (%)
	Control	25	45	55	
Control	32.33	32.99	33.38	35.18	33.47
1000	34.16	35.38	36.23	37.83	35.9
3000	35.95	36.34	38.67	41.25	38.05
Means (%)	34.15	34.90	36.09	38.09	

$LSD_{0.05}$ Potassium nitrate 0.64, Black tea leaf waste = 0.74, Interaction = 1.65

Table 6. Effect of foliar application of potassium nitrate compound and black tea leaf waste and their interaction on carbohydrates in wheat grains.

Potassium nitrate (g 1000 l^{-1})	Black tea leaf waste (g 1000 l^{-1})				Means (%)
	Control	25	45	55	
Control	12.54	14.65	15.74	16.56	14.81
1000	14.65	16.45	17.45	19.87	17.11
3000	17.65	18.56	20.73	22.74	19.92
Means (%)	14.95	16.55	17.97	19.72	

$LSD_{0.05}$ Potassium nitrate 0.41, Black tea leaf waste = 0.48, Interaction = 1.84

events (Verma and Verma, 2000). Wheat variants using potassium nitrate (3000 g 1000 l^{-1}) in interaction with black tea leaf waste (55 g 1000 l^{-1}) recorded the highest value of carbohydrate (22.74%) compared with the lowest value obtained in the interaction of both control treatments (12.54%).

CONCLUSIONS

Mixing the black tea leaf waste with the treated soil - decreases the soil pH and increases the oil yield, protein, zinc, and carbohydrate percentage in wheat (*Triticum aestivum* L.) grains. The interaction between the highest rate of potassium nitrate compound foliar application (3000 g 1000 l^{-1}) and black tea leaf waste mixing with soil (55 g 1000 l^{-1}) boosts the values of the biochemical composition of wheat grains and the soil properties.

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