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Effect of potassium fulvate, iron and zinc as foliar sprays on yield and quality of chickpea (*Cicer arietinum* L.)

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Abstract
A field experiment was conducted during Rabi 2024-25 at the College of Agriculture, Karad to evaluate the effect of foliar application of potassium fulvate extracted from vermicompost, along with iron and zinc, on yield and quality of chickpea (*Cicer arietinum* L.). Treatments consisted of graded levels of potassium fulvate (200, 400, and 600 ppm) applied alone and in combination with $FeSO_4$ and $ZnSO_4$ (0.5% each) with general recommended dose of fertilizers (GRDF). The results revealed that foliar spray of potassium fulvate at 400 ppm along with $FeSO_4$ and $ZnSO_4$ significantly increased grain yield (25.53 q ha^{-1}), straw yield (30.64 q ha^{-1}), and protein content (19.29%) as compared to control. This treatment also improved quality attributes of chickpea grains. The findings demonstrate the potential of integrating fulvate salt, Fe and Zn micronutrient foliar sprays with GRDF which improve yield and quality of chickpea cultivation.

Keywords: Chickpea, potassium fulvate, foliar spray, yield, protein, quality

Introduction
Chickpea (*Cicer arietinum* L.) is an important pulse crop in India, valued for its high protein content and its role in soil fertility restoration through biological nitrogen fixation (El-Bassiouny *et al*., 2018) [2]. Despite its significance, chickpea productivity is constrained by low soil fertility, especially deficiencies of micronutrients such as iron and zinc (Ahmad *et al*., 2019) [1]. Humic substances, particularly fulvic acids, enhance nutrient absorption, enzyme activity, and photosynthesis, leading to improved crop productivity (Mora *et al*., 2019) [6]. Potassium fulvate, extracted from good quality vermicompost, is highly bioactive and improved uptake of both macro-and micronutrients (Kolape *et al*., 2023) [5]. Foliar application of Fe and Zn in pulses has been showed to increase yield and protein content (Rane *et al*., 2019; Rehman *et al*., 2022) [8, 9]. However, limited studies are available on the combined effect of potassium fulvate with Fe and Zn on chickpea. Hence, the present investigation was undertaken to study their effect on yield and quality of chickpea.

Material and Methods
The experiment was conducted during the Rabi season of 2024-25 at the Instructional Farm, College of Agriculture, Karad (17°16′ N latitude, 74°12′ E longitude, altitude 576 m above mean sea level). The experimental soil was an Inceptisol with clay loam texture, slightly alkaline reaction (pH 7.78), low in available nitrogen (183.72 kg ha^{-1}), medium in phosphorus (13.60 kg ha^{-1}), and high in potassium (525.14 kg ha^{-1}). The organic carbon content was 0.58 percent, and the DTPA-extractable Zn and Fe content was marginal (1.12 mg kg^{-1}). The experiment was laid out in a Randomized Block Design with nine treatments replicated three times. The treatments included foliar sprays of potassium fulvate at 200, 400, and 600 ppm, applied either singly or in combination with $FeSO_4$ and $ZnSO_4$ (0.5% each), along with GRDF (25:50:25 kg $N:P_2O_5:K_2O$ ha^{-1}). Chickpea variety (Phule digvijay) was sown at 30 × 10 cm spacing with a seed rate of 80 kg ha^{-1}. The seeds were treated with Rhizobium and Trichoderma cultures prior to sowing. Two foliar sprays were applied at flower initiation (35 DAS) and pod initiation (55 DAS) using a knapsack sprayer with fine nozzles to ensure uniform coverage.

Standard crop management and plant protection practices were followed. Data were recorded on growth and physiological traits (plant height, number of branches, dry matter accumulation, and chlorophyll content at 40 and 55 DAS), yield attributes (pods plant^{-1} and 100-seed weight), grain and straw yield, and pritein content

Results and Discussion

Effect of potassium fulvate, Fe and Zn on yield of chickpea

The foliar application of potassium fulvate, iron and zinc significantly improved yield and quality attributes of chickpea.

Grain yield ranged from 14.28 q ha^{-1} in control to 25.53 q ha^{-1} in T_8 (400 ppm potassium fulvate + 0.5% $FeSO_4$ + $ZnSO_4$ with GRDF), which was statistically at par with T9 (25.50 q ha^{-1}, 600 ppm fulvate +0.5% $FeSO_4$ + $ZnSO_4$). Straw yield was also highest in T_8 (30.64 q ha^{-1}) compared to control (18.59 q ha^{-1}). These improvements may be due to enhanced nutrient availability, higher photosynthetic rate, and efficient assimilate pertaining under fulvate + micronutrient foliar sprays (Mora *et al*., 2019; El-Sayed *et al*., 2024) [6, 3].

Effect of potassium fulvate, Fe and Zn on yield of chickpea

Protein content was significantly influenced, with the maximum (19.29%) in T_8 followed by T9 (19.15%), while control recorded the lowest (17.95%). The increase in protein may be linked to enhanced nitrogen uptake and assimilation through fulvate-mediated chelation and the enzymatic role of Fe and Zn in protein synthesis (Kaur *et al*., 2020; Kolape *et al*., 2023) [4, 5].

Leaf chlorophyll content increased with fulvate and micronutrient application, with T_8 recording 2.58 mg g^{-1} FW at 40 DAS and 2.81 mg g^{-1} FW at 55 DAS, compared to 1.88 and 2.00 mg g^{-1} FW in control. Fulvic substances are known to stimulate chlorophyll synthesis and photosynthesis (Ahmad *et al*., 2019) [1].

Table 1: Effect of different levels of potassium fulvate along with 0.5% Fe and Zn on yield (q ha^{-1}) and protein of chickpea.

Tr. No	Treatment	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Protein (%)
T_1	Absolute control	14.28	16.59	17.95
T_2	GRDF (FYM 5 t ha^{-1} + 25:50:30 kg ha^{-1}N: P_2O_5:K_2O)	19.93	25.76	18.16
T_3	GRDF + $FeSO_4$ + $ZnSO_4$ @ 0.5% each as foliar spray	20.83	26.34	18.33
T_4	GRDF + 200 ppm foliar spray of potassium fulvate	21.84	27.06	18.39
T_5	GRDF + 400 ppm foliar spray of potassium fulvate	22.47	28.75	18.50
T_6	GRDF + 600 ppm foliar spray of potassium fulvate	22.73	29.16	18.62
T_7	GRDF + 200 ppm foliar spray potassium fulvate with Fe & Zn @ 0.5% each	23.86	29.55	19.04
T_8	GRDF + 400 ppm foliar spray potassium fulvate with Fe & Zn@ 0.5% each	25.53	30.64	19.29
T_9	GRDF + 600 ppm foliar spray potassium fulvate with Fe & Zn @ 0.5% each	25.50	30.35	19.25
	S.Em.±	1.33	0.76	0.14
	C.D. at 5%	4.02	2.3	0.43

Conclusion

Foliar application of 400 ppm potassium fulvate + $FeSO_4$ + $ZnSO_4$ (0.5% each) with GRDF significantly improved grain and straw yield as well as protein content in chickpea. This integrated approach found to be useful as a sustainable nutrient management practice for enhancing productivity and quality of chickpea.

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