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Effect of foliar application of humic acid and vermicompost leachate on yield and quality of soybean in vertisols

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ABSTRACT

The present investigation entitled "Effect of foliar application of humic acid and vermicompost leachate on yield and quality of soybean in vertisols". The present experiment was carried out in kharif season at All India Coordinated Research Project on Weed Management, Dr. PDKV Akola during 2025-26. The field experiment was conducted using a Randomized Block Design (RBD) with eight treatments combinations replicated thrice. The experimental soil was deep black color and had good drainage. The study aimed to evaluate the effects of foliar application of humic acid and vermicompost leachate on yield and quality of soybean.

The effect of foliar application of humic acid and vermicompost leachate was found a significant positive effect on the grain and straw yield of soybean. Among the different treatments, the application of the recommended dose of fertilizers (RDF) along with foliar spray of vermicompost leachate at 20 and 35 DAS recorded the highest grain yield of (17.00 q ha⁻¹). This treatment is at par to the RDF combined with foliar spray of humic acid at 20 DAS (14.69 q ha⁻¹), RDF with humic acid at 20 and 35 DAS (16.71 q ha⁻¹), RDF with vermicompost leachate at 20 DAS (14.82 q ha⁻¹) and RDF with foliar spray of vermicompost leachate at 35 DAS (14.78 q ha⁻¹). The highest straw yield (31.0 q ha⁻¹) was observed in treatment with RDF with foliar spray of vermicompost leachate at 20 and 35 DAS. which was found statistically at par to the all the treatment of application except RDF + foliar spray of vermicompost leachate at 20 DAS (28.0 q ha⁻¹) and absolute control (27.8 q ha⁻¹). The lowest grain yield (12.98 q ha⁻¹) and straw yield (27.8 q ha⁻¹) were observed in absolute control. The foliar application of humic acid and vermicompost leachate on protein and oil contents of soybean seeds were significantly influenced by the application of RDF + foliar spray of humic acid at 20 and 35 DAS which shows highest protein (44.87%) and oil (18.52%) percentage and lowest was observed in absolute control.

Keywords: Humic acid, Vermicompost leachate, Soybean, Vertisols, Biostimulant

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1. Introduction

Soybean [*Glycine max* (L.) Merrill] is an important grain legume and oilseed crop, widely recognized for its high nutritional and industrial value. The seeds contain approximately 40–44 per cent protein and 20 per cent oil, making soybean an important source of both dietary protein and edible oil. Because of its nutritional quality, productivity and diverse industrial uses, the crop has considerable potential for expansion in India. As a leguminous crop, soybean can tolerate periods of moisture stress to some extent and also contributes to the improvement of soil fertility and productivity through biological nitrogen fixation. In India, soybean is cultivated over an area of 12.95 million ha, producing about 15.27 million tonnes, with an average productivity of 1179 kg ha⁻¹ (Anon., 2025) [1]. Nevertheless, soybean productivity and quality in India remain comparatively low, which may be attributed to inadequate crop management, particularly improper nutrient management. The limited recycling of organic wastes and the continued dependence on readily soluble N, P and K fertilizers, often without adequate use of organic matter or humic substances, may adversely affect soil health and create long-term environmental and ecological concerns.

Humic acid is a complex organic substance containing different types of organic compounds and functional groups that can interact with several metallic ions, including Mg, Zn, Ca and Cu. It can be applied either directly to the soil or as a foliar spray. When incorporated into the soil, humic acid may improve soil structure, aeration and nutrient availability. Foliar application, on the other hand, can enhance nutrient absorption through the leaves and may contribute to improved membrane permeability and photosynthetic activity. Thus, humic acid has potential as a biostimulant for improving plant growth and nutrient utilization (Hudda et al., 2020) [2].

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Vermiwash is another organic biostimulant that is commonly applied as a foliar spray. It contains several essential nutrients, including N (0.29%), P (0.042%), K (0.143%), Ca (0.186%), Mg (0.11%), S (0.058%), Fe (0.466 ppm), Mn (0.406 ppm), Zn (0.11 ppm) and Cu (0.18 ppm). It is generally described as a transparent, pale-yellow to brown coloured liquid biofertilizer containing excretory materials and mucous secretions of earthworms along with soluble organic and micronutrient components. Because of its nutrient content and biological constituents, vermiwash has the potential to function as a supplementary biofertilizer and biostimulant for promoting crop growth, nutrient uptake and yield (Godara *et al.*, 2020) [3].

2. Material and methods

Akola district is located in the subtropical region at 22°42' N latitude and 77°02' E longitude, with an elevation of approximately 307.42 m above mean sea level. The field experiment was conducted during the Kharif season of 2025–26 at the All India Coordinated Research Project on Weed Management, Dr. PDKV, Akola. The experiment was laid out in a Randomized Block Design (RBD) comprising eight treatments, each replicated three times. The experimental field had deep black soil with good drainage. The study was undertaken to assess the influence of foliar application of humic acid (HA) and vermicompost leachate (VL) on nutrient uptake, yield and quality of soybean. The treatments included absolute control (T_1), RDF (T_2), RDF + foliar spray of HA at 20 DAS (T_3), RDF + foliar spray of HA at 35 DAS (T_4), RDF + foliar spray of HA at 20 and 35 DAS (T_5), RDF + foliar spray of VL at 20 DAS (T_6), RDF + foliar spray of VL at 35 DAS (T_7), and RDF + foliar spray of VL at 20 and 35 DAS (T_8). Before the commencement of the experiment, a representative soil sample was collected from a depth of 0–30 cm to characterize the initial soil conditions of the experimental field. The collected soil was thoroughly mixed, and the required quantity was obtained by the quartering method and packed in polythene bags for laboratory analysis. The initial soil analysis indicated that the soil was slightly alkaline, with a pH of 7.78 and electrical conductivity of 0.12 dS m⁻¹. The soil contained 0.58 per cent organic carbon, while the available N, P, K and S were 147.10, 10.00, 302.00 and 10.01 kg ha⁻¹, respectively. The initial DTPA-extractable Fe, Mn, Zn and Cu contents were 4.62, 4.65, 0.60 and 0.68 ppm, respectively.

3. Results and discussion

3.1. Effect of foliar application of humic acid and vermicompost leachate on yield of soybean

3.2. Effect of foliar application of humic acid and vermicompost leachate on quality of soybean

3.1.1 Grain yield

The effect of foliar application of humic acid and vermicompost leachate on yield of soybean was studied in table no 14. The grain yield of soybean was observed to vary between 12.98 and 17.00 q ha⁻¹. The highest grain yield (17.00 q ha⁻¹) was recorded in treatment recommended dose of fertilizers (RDF) along with foliar sprays of vermicompost leachate at 20 and 35 DAS followed by RDF with humic acid at 20 and 35 DAS (16.71 q ha⁻¹), RDF with vermicompost leachate at 20 DAS (14.82 q ha⁻¹), RDF with foliar spray of vermicompost leachate at 35 DAS (14.78 q ha⁻¹) and RDF combined with foliar spray of humic acid at 20 DAS (14.69 q ha⁻¹). This treatment was found statistically significant over the treatment absolute control (12.98 q ha⁻¹) and RDF (14.14 q ha⁻¹). But it was recorded at par

with the treatment RDF combined with foliar spray of humic acid at 20 DAS (14.69 q ha⁻¹), RDF with humic acid at 20 and 35 DAS (16.71 q ha⁻¹), RDF with vermicompost leachate at 20 DAS (14.82 q ha⁻¹) and RDF with foliar spray of vermicompost leachate at 35 DAS (14.78 q ha⁻¹). The lowest grain yield (12.98 q ha⁻¹) was recorded in absolute control.

The increase in yield may be attributed to the beneficial effects of humic acid and vermicompost leachate in enhancing nutrient availability, improving physiological processes, and promoting better plant growth. Similar findings were reported by Kapase *et al.* (2014) [4], who observed that the application of humic acid-based organic fertilizers significantly enhanced soybean yield. Supporting findings was given by Gaikwad *et al.* (2012) [5], Deotale *et al.* (2017) [6].

3.1.2 Straw yield

The effect of foliar application of humic acid and vermicompost leachate on straw yield of soybean was showed in table no 14. The straw yield of soybean was recorded in the range of 27.8 q ha⁻¹ to 31.0 q ha⁻¹. The highest straw yield (31.0 q ha⁻¹) was observed in treatment with RDF with foliar spray of vermicompost leachate at 20 and 35 DAS followed by RDF with humic acid at 20 and 35 DAS (30.7 q ha⁻¹), RDF with foliar spray of vermicompost leachate at 35 DAS (29.6 q ha⁻¹) and RDF with humic acid at 35 DAS (29.6 q ha⁻¹). This treatment was found statistically significant over the treatment absolute control (27.8 q ha⁻¹) and RDF with foliar spray of vermicompost leachate at 20 DAS (28.0 q ha⁻¹). This treatment was found statistically at par to the all the treatment of application except RDF + foliar spray of vermicompost leachate at 20 DAS (28.0 q ha⁻¹) and absolute control (27.8 q ha⁻¹). The lowest straw yield (27.8 q ha⁻¹) was recorded in the absolute control.

Savita *et al.* (2018) [7] who attributed the increase in straw yield to improved growth parameters, enhanced activity of plant growth regulators, and higher dry matter accumulation in vegetative plant parts. Comparable findings were also reported by Kadam *et al.* (2008) [8] and Dandge *et al.* (2016) [9].

3.2. Effect of foliar application of humic acid and vermicompost leachate on quality of soybean

3.2.1 Protein (%)

The effect of foliar application of humic acid and vermicompost leachate on protein content in soybean was recorded in table no 15. The data showed that protein content found significantly affected by various treatments. The protein content in soybean seed was ranged from 35.80 to 44.87 %. The highest protein content (44.87%) was recorded with RDF + foliar spray of humic acid at 20 and 35 DAS followed by RDF + foliar spray of vermicompost leachate at 20 and 35 DAS (44.34 %), RDF with humic acid at 35 DAS (42.72 %), RDF with humic acid at 20 DAS (42.50 %) and RDF with vermicompost leachate at 20 DAS (42.14 %). This treatment was found statistically at par with RDF + foliar spray of vermicompost leachate at 20 and 35 DAS (44.34 %), RDF with humic acid at 35 DAS (42.72 %), RDF with humic acid at 20 DAS (42.50 %), RDF with vermicompost leachate at 20 DAS (42.14 %) and RDF with vermicompost leachate at 35 DAS (42.12 %). In comparison, the lowest protein content (35.80%) was recorded in the absolute control.

Yathish *et al.* (2021) [10] stated that humic acid stimulates plant growth through the assimilation of major and minor nutrients, activation or inhibition of enzymes, changes in membrane permeability, and protein synthesis. Similar results reported by Thakur *et al.* (2013) [11], Prasad *et al.* (2016) [12], Ahmed *et al.* (2012) [13] and Kaya *et al.* (2005) [14].

Table 1. Effect of foliar application of humic acid and vermicompost leachate on yield of Soybean:

Treatment No.	Treatment Details	Grain Yield (q ha ⁻¹)	Straw Yield (q ha ⁻¹)
T ₁	Absolute Control	12.98	27.8
T ₂	RDF (Control)	14.14	29.3
T ₃	RDF + Foliar spray of HA at 20 DAS	14.69	29.5
T ₄	RDF + Foliar spray of HA at 35 DAS	14.32	29.6
T ₅	RDF + Foliar spray of HA at 20 & 35 DAS	16.71	30.7
T ₆	RDF + Foliar spray of VL at 20 DAS	14.82	28.0
T ₇	RDF + Foliar spray of VL at 35 DAS	14.78	29.6
T ₈	RDF + Foliar spray of VL at 20 & 35 DAS	17.00	31.0
SE(±)m		0.80	0.63
CD @ 5%		2.42	1.92

Table 2. Effect of foliar application of humic acid and vermicompost leachate on quality of soybean:

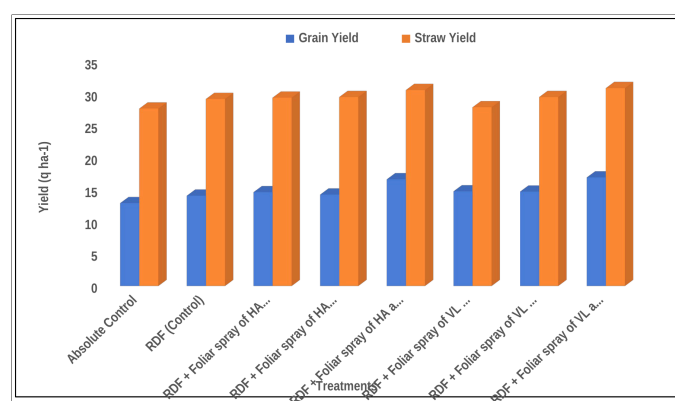
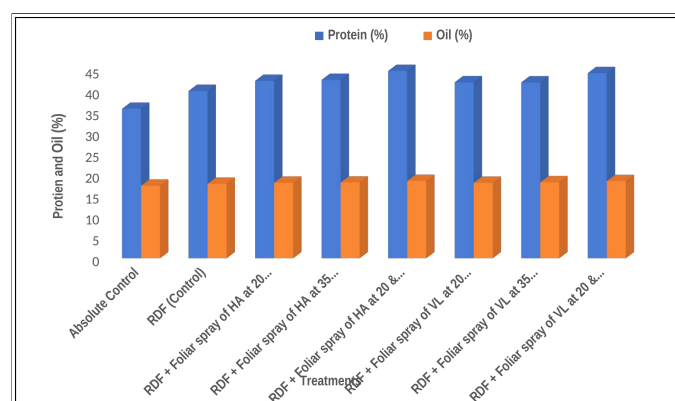
Treatment No.	Treatment Details	Protein (%)	Oil (%)
T ₁	Absolute Control	35.80	17.37
T ₂	RDF (Control)	40.08	17.83
T ₃	RDF + Foliar spray of HA at 20 DAS	42.50	18.10
T ₄	RDF + Foliar spray of HA at 35 DAS	42.72	18.13
T ₅	RDF + Foliar spray of HA at 20 & 35 DAS	44.87	18.52
T ₆	RDF + Foliar spray of VL at 20 DAS	42.14	18.07
T ₇	RDF + Foliar spray of VL at 35 DAS	42.12	18.20
T ₈	RDF + Foliar spray of VL at 20 & 35 DAS	44.34	18.48
—	SE (±) m	1.14	0.12
—	CD @ 5%	3.46	0.37

4.4.2 Oil (%)

The effect of foliar application of humic acid and vermicompost leachate on oil content in seeds of soybean was presented in table 15. The application of humic acid and vermicompost leachate through foliar spray significantly influenced the soybean seed oil content. The oil content in soybean seed was ranged from 17.37 to 18.52 %. The maximum oil content (18.52%) was recorded with the application of the recommended dose of fertilizer (RDF) along with foliar spraying of humic acid at 20 and 35 DAS followed by RDF + foliar spray of vermicompost leachate at 20 and 35 DAS (18.48%) and RDF + foliar spray of vermicompost leachate at 35 DAS (18.20%). This treatment was found statistically at par with RDF + foliar spray of vermicompost leachate at 20 and 35 DAS (18.48%) and RDF + foliar spray of vermicompost leachate at 35 DAS (18.20%). In contrast, the lowest oil content (17.37%) was recorded in the absolute control.

Kumar *et al.* (2016) [15] recorded that the application of RDF along with humic acid @ 15.0 kg ha⁻¹ resulted in the highest oil yield (497 kg ha⁻¹) compared with the other treatments. The increase in oil content may be attributed to the role of humic substances in improving nutrient availability and uptake, thereby enhancing plant growth and metabolic activities associated with oil synthesis. Similar findings

were recorded by Moradi *et al.* (2017) [16], Hendawy *et al.* (2015) [17].

**Figure 1.** Yield (q ha⁻¹) of soybean influenced by foliar application of humic acid and vermicompost leachate.**Figure 2.** Protein and Oil percent of seed influenced by foliar application of humic acid and vermicompost leachate.

Conclusion

Based on the data generated during the investigation, it was concluded that the application of RDF + foliar spray of vermicompost leachate at 20 and 35 DAS recorded the highest grain and straw yields of soybean, followed by the application of RDF + foliar spray of humic acid at 20 and 35 DAS. The oil and protein content of soybean seeds was significantly influenced by the application of RDF + foliar spray of humic acid at 20 & 35 DAS which shows highest percentage and lowest was observed in absolute control.

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