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Effect of humic acid on yield of soybean in swell -shrink soils of Maharashtra

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ABSTRACT

A field experiment was conducted during the kharif season of 2025–26 at the Research Farm, Department of Soil Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, to study the effect of humic acid on yield of soybean. The experiment was conducted using soybean cv. PDKV Amba in a randomized block design with six treatments replicated four times. The treatment consisted T_1 : absolute control, T_2 : 100% recommended dose of fertilizer (RDF), T_3 : 75% RDF, T_4 : 75% RDF + foliar application of humic acid @ 100 ml per 10 L water, T_5 : 75% RDF + humic acid @ 200 ml per 10 L water and T_6 : 75% RDF + humic acid @ 300 ml per 10 L water at 30 and 45 days after sowing. The results revealed that application of 75% RDF + foliar spray of humic acid @ 300 ml per 10 L water significantly influenced grain and straw yield of soybean. The highest grain yield (23.18 q ha⁻¹) and straw yield (32.82 q ha⁻¹) were recorded with 75% RDF + humic acid @ 300 ml per 10 L water, which was statistically at par with the application of 75% RDF + humic acid @ 200 ml per 10 L water. The lowest grain yield (18.63 q ha⁻¹) and straw yield (26.50 q ha⁻¹) were observed under the absolute control. Hence, it can be concluded that application of 75% RDF + foliar spray of humic acid @ 300 ml or 200 ml per 10 L water at 30 and 45 days after sowing was found equally effective for enhancing grain and straw yield of soybean.

Keywords: Soybean, Humic acid, Yield

Introduction

Soybean (*Glycine max* L.) is an important oilseed and protein-rich crop cultivated widely across the world. It is valued for its high-quality edible oil and protein-rich seed and serves as an important source of food and livestock feed. Globally, soybean is cultivated on more than 140 million hectares, with annual production exceeding 390 million tonnes. Brazil, the United States, Argentina, China and India are among the major soybean-producing countries (FAOSTAT, 2024). In India, soybean is an important kharif oilseed crop, particularly in Madhya Pradesh and Maharashtra. During 2024–25, it occupied about 12.95 million hectares, producing approximately 15.27 million tonnes with an average productivity of 1179 kg ha⁻¹ (DA&FW, 2024). Being a leguminous crop, soybean also contributes to soil fertility through biological nitrogen fixation and its deep root system (Ryan *et al.*, 2018).

Despite its importance, soybean productivity and quality are often constrained by inadequate and imbalanced nutrient management. Continuous dependence on chemical fertilizers with insufficient addition of organic sources may adversely affect soil health and nutrient-use efficiency. Soil organic carbon plays a vital role in maintaining soil quality and fertility, while regular replenishment of organic matter is essential for sustainable crop production (Liu *et al.*, 2006; Deore *et al.*, 2023) [2, 1]. However, the application of bulky organic manures involves considerable labour and transportation costs. Therefore, the use of concentrated organic products such as humic substances offers a potential approach for improving soil condition, nutrient-use efficiency and crop productivity (Savita *et al.*, 2018) [3].

Humic acid is an important component of soil humus and has beneficial effects on soil properties, plant growth and nutrient uptake (Serenella *et al.*, 2002) [4]. Leonardite is considered an important natural source of humic acid (Dulaimy *et al.*, 2020) [5]. Application of humic substances can promote root development, nutrient absorption, physiological activity and stress tolerance, and may enhance nodulation and nitrogen fixation in leguminous crops (Zhang *et al.*, 2023). In addition, hydrothermal humification of biomass wastes has been proposed as an alternative approach for producing artificial humic acid from renewable resources (Yang *et al.*, 2019) [6]. Thus, humic acid application may provide an effective strategy for improving nutrient-use efficiency, productivity and quality of soybean under sustainable nutrient management. Therefore, the present investigation was undertaken to study the effect of humic acid on yield of soybean in swell -shrink soils of Maharashtra.

Material and methods

The field experiment was conducted during *kharif* 2025–26 at the Research Farm, Department of Soil Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India. Geographically, the experimental site is located at 20°42'01.13" North latitude and 77°03'47.93" East longitude, at an elevation of 307.8 m above mean sea level (MSL). The region has a semi-arid climate with three well-defined seasons, namely, hot and dry summer from March to May, warm and rainy monsoon from June to October, and mild to cold winter from November to February. The average annual precipitation is 711.1 mm. The soil of the experimental site was deep, clayey black soil, taxonomically classified as very fine, smectitic, calcareous, hyperthermic family of Typic Haplusterts.

The experiment was conducted with soybean (*Glycine max* L.) cv. PDKV Amba in a randomized block design with six treatments and four replications. The treatments comprised absolute control (T_1), 100% recommended dose of fertilizer (RDF) (T_2), 75% RDF (T_3), 75% RDF + foliar application of humic acid @ 100 ml per 10 L water at 30 and 45 days after sowing (DAS) (T_4), 75% RDF + foliar application of humic acid @ 200 ml per 10 L water at 30 and 45 DAS (T_5), and 75% RDF + foliar application of humic acid @ 300 ml per 10 L water at 30 and 45 DAS (T_6). The recommended dose of fertilizer for soybean was 60:30:30 kg N: P_2O_5 : K_2O ha^{-1} . The required quantity of fertilizer was applied at sowing as per the respective treatment. In humic acid treatments, foliar application was carried out at 30 and 45 DAS at the specified concentrations. The crop was maintained under uniform agronomic practices throughout the growing season, except for the treatment-wise application of fertilizers and humic acid.

At harvest, the soybean plants from the net plot area were harvested separately for each treatment and replication. The harvested produce was sun-dried and threshed to separate the grain from the straw. Grain yield was recorded after threshing and cleaning, while straw yield was obtained from the remaining above-ground biomass. The grain and straw yields were expressed in $q\ ha^{-1}$. The recorded data on grain yield and straw yield were statistically analysed using analysis of variance (ANOVA) appropriate for a Randomized Block Design (RBD), as described by Gomez *et al.* (1984) [7]. Treatment means were compared using the critical difference (CD) at the 5 per cent level of significance.

Results and discussion

Grain and fodder yields of soybean varied significantly with different nutrient management practices (Fig. 1). The results indicated that the different treatments of humic acid along recommended dose of fertilizer significantly influenced the yield of soybean. The application of 75 % RDF + foliar spray of HA @ 300 ml per 10 L water was found significantly highest grain yield of soybean (23.18 $q\ ha^{-1}$) which was at par with spray of HA @ 200 ml per 10 L and 75 % RDF + foliar spray of @ 100 ml per 10 L water. The result further indicated that balanced fertilizer i.e 100 % RDF was also found superior for enhancing grain yield of soybean over absolute control.

An increase in soybean grain yields due to humic acid @ 300 ml per 10 L water and 200 ml per 10 L water along with 75 % RDF (T_6 and T_5) was 9.65 and 7.28 % respectively over 100 % RDF. In general, the trend of grain yield of soybean among various treatment was as follows 75 % RDF + HA @ 300 ml 10 L water > 75 % RDF + HA @ 200 ml per 10 L water > 75% RDF + HA @ 100 ml per 10 L water > 100 % RDF > 75 RDF > Absolute control.

The straw yield of soybean was also influenced due to the application of humic acid (Fig.2). The significantly highest straw yield of soybean is (32.82 $q\ ha^{-1}$) was noticed due to combined application of 75% RDF + humic acid @ 300 ml per 10 L water (T_6) followed by 75 % RDF + HA @ 200 ml per 10 L water (T_5) and 100 % RDF through chemical fertilizers (T_2). The increase in straw yield with T_6 was 6.01 % over 100 % RDF.

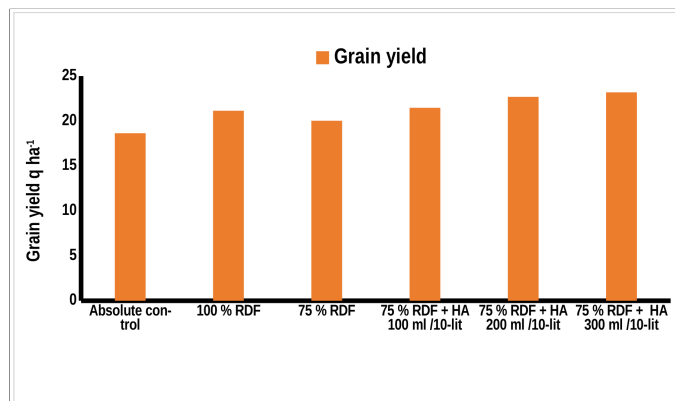


Figure 1. Effect of humic acid on grain yield ($kg\ ha^{-1}$) of soybean.

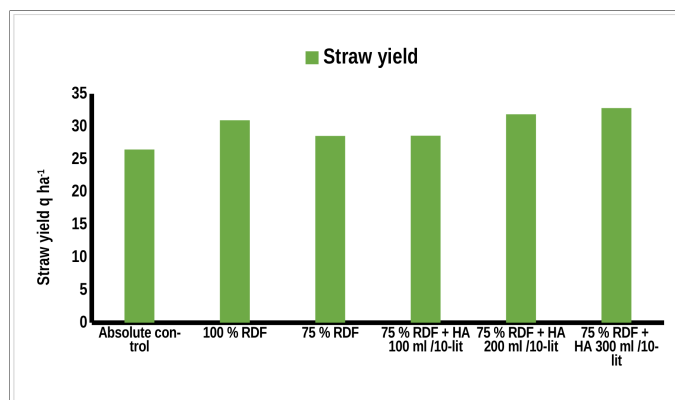


Figure 2. Effect of humic acid on straw yield ($kg\ ha^{-1}$) of soybean.

The significant increase in yield of soybean due to humic acid because humic acid spraying facility facilitates rapid nutrient absorption which boost root and shoot growth with improving pod setting and seed output by primarily reducing blossom drop (Lingaraju *et al.*, 2016). These results are corroborate with the findings of Rachmandhika (2026) [8], Ali *et al.* (2023) [9] and Kadam *et al.* (2025) [10].

Conclusion

Thus, foliar application of humic acid @ 300 ml or 200 ml per 10 L water along with 75% RDF was found equally beneficial for enhancing soybean yield on swell-shrink soils of Maharashtra.

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