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Effect of soil and foliar application of Humic Acid on growth and yield of black gram (*Vigna mungo* L.) in northern hill zone of Chhattisgarh

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Abstract

at 20 and 35 DAS (T_6), T_5 + Foliar Application of Humic Acid@ 0.4% at 20 and 35 DAS (T_7) and RDF (50%) + Vermi Compost + Foliar Application of Humic Acid@ 0.2% at 20 and 35 DAS (T_8). The study revealed that T_6 (RDF + soil application of humic acid @ 25 kg ha⁻¹ + foliar application @ 0.2% at 20 and 35 DAS) recorded the plant height, number of primary and secondary branches, dry matter accumulation, pods per plant, pod length, pod weight, seeds per pod and test weight, seed and stover yields of black gram. It was statistically at par with T_7 (RDF + soil application @ 35 kg ha⁻¹ + foliar application @ 0.4%) and significantly superior to other treatments. In contrast, the lowest values for growth, yield attributes and yield were observed under T_1 – RDF (20:40:20 kg ha⁻¹ NPK). The economic analysis revealed that the application of T_6 – RDF + Soil Application of Humic Acid @ 25 kg ha⁻¹ + Foliar Application of Humic Acid @ 0.2% at 20 and 35 DAS recorded the highest economic returns among all the treatments. It registered the maximum gross return (₹105,363.62 ha⁻¹), net return and benefit: cost ratio (1.93), indicating its superior profitability. In contrast, the lowest gross return, net return and benefit: cost ratio were recorded under T_1 – RDF (20:40:20 kg ha⁻¹ NPK).

Keywords: Black gram, humic acid, vermi compost, pods, economic and soil

Introduction

Pulses occupy a vital position in Indian agriculture due to their nutritional importance and contribution to sustainable farming systems. India is the largest producer and consumer of pulses in the world, with about 28.78 million hectares under cultivation and a production of 25.46 million tonnes (Anonymous, 2021) ^[1]. Pulses are rich in protein, essential amino acids, vitamins, minerals, and dietary fibre. They also improve soil fertility by fixing atmospheric nitrogen through symbiotic association, thereby reducing the requirement for chemical fertilizers and enhancing the sustainability of cropping systems. Among the pulse crops, black gram (*Vigna mungo* L. Hepper), commonly known as urdbean, is one of the most important grain legumes cultivated in India. It is an ancient crop believed to have originated from *Vigna silvestris* and has been cultivated in India since prehistoric times (Chandar *et al.*, 2023) ^[6]. Black gram seeds contain about 24 per cent protein, 1.3 per cent fat, 3.5–4.5 per cent fibre, and nearly 60 per cent carbohydrates. It is widely consumed as dal and is an important ingredient in traditional foods such as idli and dosa. Black gram occupies about 4.8 million hectares with an annual production of 2.7 million tonnes in India (Anonymous, 2024) ^[2]. In Chhattisgarh, it is cultivated mainly in districts such as Surguja, Jashpur, Bilaspur, Raipur, Rajnandgaon, and Kanker. However, its productivity remains low due to cultivation under rainfed conditions, poor soil fertility, and moisture stress, highlighting the need for improved nutrient management practices.

Humic acid is an important organic component of soil organic matter formed during the decomposition of plant and animal residues. Although it is not a fertilizer, it acts as an effective soil conditioner by improving soil structure, aeration, water-holding capacity, nutrient retention, and microbial activity. It also enhances nutrient uptake, stimulates root growth, and improves crop performance. Humic acid possesses a high cation exchange capacity, which reduces nutrient losses and increases nutrient use efficiency (Moura *et al.*, 2023) ^[14]. According to Sivasankar *et al.*, (2018) ^[19], humic acid contains about 51–57 per cent carbon, 4–6 per cent nitrogen, and 0.2–1.0 per cent phosphorus, along with traces of essential micronutrients.

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Humic acid plays a significant role in plant growth by influencing plant physiology and enhancing the physical, chemical and biological properties of soil. It is known to increase the permeability of plant membranes, leading to higher metabolic activity within the plant. This results in more efficient nutrient uptake and overall plant growth. In terms of improving soil properties, humic acid enhances soil structure, leading to better tilth, aeration and moisture retention. These physical improvements make the soil more conducive to plant growth by ensuring better root penetration and water availability. Humic acid is a major fraction of humic substances and constitutes an important component of soil humus, peat, lignite, and other highly decomposed organic materials. It is formed during the decomposition and humification of organic matter and plays a vital role in maintaining soil fertility and plant growth. Although humic acid is not considered a conventional fertilizer, it acts as an effective soil conditioner by improving the physical, chemical, and biological properties of the soil. Its application enhances soil structure, water-holding capacity, aeration, and nutrient retention, thereby facilitating better root growth and nutrient uptake. Humic acid also contributes to the regulation of soil moisture and nutrient availability, resulting in improved crop performance. According to Sivasankar *et al.* (2018) ^[19], humic acid contains approximately 51–57 per cent carbon, 4–6 per cent nitrogen, and 0.2–1.0 per cent phosphorus, along with trace amounts of essential micronutrients, making it a valuable organic mineral amendment for sustainable crop production. Biologically, humic acid stimulates the growth and activity of beneficial soil microorganisms, which enhances organic matter decomposition and nutrient cycling. These improvements in soil health create a favorable environment for root development, nutrient uptake and overall crop growth, ultimately leading to increased productivity and sustainability of agricultural systems. Humic substances originate from chemical and biological degradation of plant and animal residues and from synthetic activities of microorganisms. Coal is also found to produce humus matter on degradation. Peat and lignite are reported to have higher content of humic acid.

Materials and Methods

A field experiment was conducted at Instructional Farm, RMD College of Agriculture and Research Station, Ambikapur (C.G.) during *Kharif* season 2025. The experiment was laid out in Randomized Block Design with three replications. The treatments consisted of eight nutrient management practices viz., RDF (20:40:20) Kg/ha NPK (T_1), RDF + Foliar Application of Humic Acid @ 0.2% at 20 and 35 DAS (T_2), RDF + Foliar Application of Humic Acid @ 0.4% at 20 and 35 DAS (T_3), RDF + Soil Application of Humic Acid @ 25Kg/ha (T_4), RDF + Soil Application of Humic Acid @ 35Kg/ha (T_5), T_4 + Foliar Application of Humic Acid @ 0.2% at 20 and 35 DAS (T_6), T_5 + Foliar Application of Humic Acid @ 0.4% at 20 and 35 DAS (T_7) and RDF (50%) + Vermi Compost + Foliar Application of Humic Acid @ 0.2% at 20 and 35 DAS (T_8). Observations on plant height, number of branches (primary and secondary), dry matter

accumulation were recorded at 30, 60 DAS and at harvest. Yield attributes, viz., number of pods, pod length, pod weight and number of grains, test weight, seed yield and stover yield of black gram crop were recorded at harvest and statistically analyzed. Economics of black gram as a net return, gross return and benefit cost ratio were also worked out.

Results and Discussion

Growth parameter

Growth parameters of black gram recorded at 30 DAS, 60 DAS and at harvest showed significant variation among the treatments. The results revealed that T_6 (RDF + Soil Application of Humic Acid @ 25 kg ha⁻¹ + Foliar Application of Humic Acid @ 0.2% at 20 and 35 DAS) recorded the highest plant height (16.43, 47.71 and 58.40 cm), primary branches (3.29, 7.89 and 11.04 plant⁻¹), secondary branches (8.38, 20.19 and 20.40 plant⁻¹), and dry matter accumulation (2.76, 7.10 and 10.12 g plant⁻¹) at 30 DAS, 60 DAS and harvest, respectively. This treatment remained statistically at par with T_7 (RDF + Soil Application of Humic Acid @ 35 kg ha⁻¹ + Foliar Application of Humic Acid @ 0.4% at 20 and 35 DAS), whereas the lowest values for these growth parameters were recorded under T_1 (RDF @ 20:40:20 kg ha⁻¹ NPK).

The improvement in growth parameters under T_6 indicates that the integrated application of humic acid effectively enhanced nutrient availability, root development and physiological processes, resulting in increased plant height, branching, dry matter accumulation, CGR and RGR. Enhanced photosynthetic activity and efficient nutrient utilization promoted vigorous vegetative growth throughout the crop period. Although flowering occurred relatively earlier under this treatment, the variation in days to 50% flowering was not statistically significant. These results corroborate the findings of Patil *et al.*, (2011) ^[15], Kumar *et al.*, (2017a, 2017b) ^[11, 12], Tripura *et al.*, (2017) ^[21], Ahmad *et al.*, (2020) and Santosh *et al.*, (2020) ^[18].

Seed and stover yield

Seed yield and stover yield differed significantly among the treatments. The highest seed yield (11.16 q ha⁻¹) and stover yield (24.62 q ha⁻¹) were recorded under T_6 (RDF + Soil Application of Humic Acid @ 25 kg ha⁻¹ + Foliar Application of Humic Acid @ 0.2% at 20 and 35 DAS), which was statistically at par with T_7 (10.97 and 24.30 q ha⁻¹, respectively). The lowest seed yield (7.16 q ha⁻¹) and stover yield (17.75 q ha⁻¹) were recorded under T_1 (RDF @ 20:40:20 kg ha⁻¹ NPK).

The significant increase in seed and stover yield under T_6 could be attributed to improved biomass production, efficient nutrient utilization and greater translocation of photosynthates to reproductive organs. The enhancement of yield components further contributed to higher productivity, whereas the RDF-alone treatment produced comparatively lower yields because of limited nutrient availability. These findings are consistent with those reported by Santosh *et al.*, (2020) ^[18], Javed *et al.*, (2024) ^[9], Mane *et al.*, (2024) ^[13] and Duany *et al.*, (2025) ^[7].

Table 1: Effect of soil and foliar application of Humic Acid on plant height (cm), Number of primary branches plant⁻¹, Number of secondary branches plant⁻¹, Dry matter accumulation (g plant⁻¹) and Seed yield (q ha⁻¹) of black gram (*Vigna mungo* L.).

Treatment details	Plant height (cm)			Number of primary branches plant ⁻¹			Number of secondary branches plant ⁻¹			Dry matter accumulation (g plant ⁻¹)			Seed yield (q/ha)
	At 30 DAS	At 60 DAS	At harvest	At 30 DAS	At 60 DAS	At harvest	At 30 DAS	At 60 DAS	At harvest	At 30 DAS	At 60 DAS	At harvest	
T ₁ - RDF (20:40:20) Kg/ha NPK	9.36	27.18	33.27	2.09	4.54	6.36	5.28	12.73	12.86	1.75	4.48	6.32	7.16
T ₂ - RDF + Foliar Application of Humic Acid @ 0.2% at 20 and 35 DAS	12.97	37.66	46.10	2.59	6.23	8.72	6.58	15.87	16.03	2.18	5.58	7.95	8.62
T ₃ - RDF + Foliar Application of Humic Acid @ 0.4% at 20 and 35 DAS	13.36	38.80	47.49	2.67	6.41	8.98	6.81	16.42	16.58	2.24	5.77	8.23	8.96
T ₄ - RDF + Soil Application of Humic Acid @ 25Kg/ha	13.87	40.28	49.30	2.77	6.66	9.32	6.97	16.80	16.97	2.33	5.91	8.42	9.34
T ₅ - RDF + Soil Application of Humic Acid @ 35Kg/ha	14.03	40.74	49.87	2.81	6.73	9.43	7.15	17.23	17.40	2.36	6.06	8.64	9.58
T ₆ - T ₄ + Foliar Application of Humic Acid @ 0.2% at 20 and 35 DAS	16.43	47.71	58.40	3.29	7.89	11.04	8.38	20.19	20.40	2.76	7.10	10.12	11.16
T ₇ - T ₅ + Foliar Application of Humic Acid @ 0.4% at 20 and 35 DAS	16.16	46.93	57.44	3.21	7.76	10.87	8.25	19.87	20.07	2.70	6.99	9.96	10.97
T ₈ - RDF (50%) + Vermi Compost + Foliar Application of Humic Acid @ 0.2% at 20 and 35 DAS	9.47	27.50	33.66	2.18	4.64	6.50	5.44	13.11	13.25	1.83	4.61	6.51	7.44
SEm (±)	0.65	2.01	2.47	0.16	0.37	0.51	0.32	0.84	0.86	0.12	0.30	0.43	0.45
CD (5%)	1.98	6.09	7.48	0.49	1.12	1.56	0.98	2.56	2.61	0.37	0.92	1.31	1.36
CV (5%)	8.56	9.07	9.10	10.28	10.06	10.01	8.16	8.84	8.93	9.31	9.04	9.02	8.47

Conclusion

The results showed that growth parameters of black gram, viz., plant height, number of primary and secondary branches & dry matter accumulation and yield attributes, like number of pods per plant, pod length, pod weight per plant, number of seeds per pod & test weight were found to be higher under treatment T₆ - RDF + Soil Application of Humic Acid @ 25 kg ha⁻¹ + Foliar Application of Humic Acid @ 0.2% at 20 and 35 DAS and was significantly superior to all other treatments. While the lowest under T₁ - RDF (20:40:20 kg ha⁻¹ NPK). The yield parameters, viz., seed yield and stover yield, were also recorded maximum under T₆ - RDF + Soil Application of Humic Acid @ 25 kg ha⁻¹ + Foliar Application of Humic Acid @ 0.2% at 20 and 35 DAS, which remained statistically at par with T₇ - RDF + Soil Application of Humic Acid @ 35 kg ha⁻¹ + Foliar Application of Humic Acid @ 0.4% at 20 and 35 DAS and significantly superior over all other treatments. The economic parameters, like gross returns, net returns and benefit: cost ratio, were significantly higher under T₆ - RDF + Soil Application of Humic Acid @ 25 kg ha⁻¹ + Foliar Application of Humic Acid @ 0.2% at 20 and 35 DAS. The highest gross return (₹105,363.62 ha⁻¹) and benefit: cost ratio (1.93) was also recorded under T₆. However, the minimum gross return, net return and benefit: cost ratio were observed under T₁ - RDF (20:40:20 kg ha⁻¹ NPK).

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