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Organic manures and biostimulants: A synergistic approach to boosting ashwagandha growth and yield

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Abstract
This study investigated the effects of organic manures and biostimulants on the growth and root yield of ashwagandha (*Withania somnifera* (L.) Dunal), a valuable medicinal herb widely used in Ayurvedic and Unani medicine. A field experiment was conducted at the Kerala Agricultural University, Vellanikkara from 2023 to 2024. The experiment followed a Factorial Randomized Block Design (FRBD) with 16 treatment combinations and three replications. The treatments included two factors: organic manures and biostimulants. Factor A consisted of four levels of organic manures: A1: FYM @ 5t/ha, A2: FYM @ 10 t/ha, A3: Vermicompost @ 2.5 t/ha, A4: Vermicompost @ 5 t/ha. Factor B included four levels of biostimulants: B1: Water spray (control), B2: Seaweed extract @ 0.4% at 1 and 3 MAP, B3: Humic and fulvic acid @ 0.4% @ 1 and 3 MAP, B4: Chitosan @ 0.1% at 1 and 3 MAP. Results demonstrated that vermicompost application at 5 t/ha resulted in significantly greater plant height (59.34 cm), biomass (141.35 g fresh and 53.98 g dry), and root development compared to other treatments. Seaweed extract as a biostimulant yielded the highest root growth and plant biomass, showing a 28.5% increase in root biomass. The findings indicate that organic farming significantly improves ashwagandha growth and yield, resulting in substantial export potential.

Keywords: *Withania somnifera*, ashwagandha, organic manures, vermicompost, seaweed extract, biostimulants

1. Introduction
The winter cherry (*Withania somnifera* (L.) Dunal), called Indian Ginseng, is an annual medicinal herb from the Solanaceae family. Its Sanskrit name ashwagandha comes from the horse sweat-like smell of its roots. The plant is widely found in the dry areas of subtropical regions and the upper Gangetic plains, and it is known for its drought resistance and hardiness. It naturally occurs in dry regions of the Mediterranean, South Africa, tropical Africa, the Middle East, Arabia, Sri Lanka, Pakistan, Afghanistan, Baluchistan, China, Nepal, and India. (Kumar *et al*., 2023) [7].

For over 5,000 years, this herb has been extensively utilized in Ayurvedic and Unani medicine. It is often referred to as a 'rasayana herb' due to its rejuvenating qualities. Extracts from ashwagandha roots have been applied to treat cancer, anxiety, inflammation, and neurological conditions. The plant is rich in various phytochemicals, including alkaloids, steroidal lactones, saponins, nitrogen-containing compounds, salts, and flavonoids. More than 12 alkaloids, 40 withanolides, and numerous gluco-withanolides (sitoindosides) have been identified from this plant (Kaur *et al*., 2017) [4].

The medicinal properties of ashwagandha drive strong market demand. In order to take advantage of this demand, organic cultivation is recommended. Organic farming methods optimize production quality and quantity, aligning with global market preferences. As a result, organically grown ashwagandha commands higher prices than conventional farming practices.

Organic manures like farmyard manure (FYM) and vermicompost offer several benefits. They enhance the biological properties of soil and provide essential nutrients, including micronutrients, at a gradual and consistent pace throughout the plant's growth. Biostimulants can boost plant metabolism and enzymatic activity, improving crop quality and yield. Kauffman *et al*. (2007) [3] initially defined biostimulants as substances, distinct from fertilizers, that promote

plant growth when used in small amounts. Du Jardin (2015) [1] described plant biostimulants as any substance or microorganism applied to plants to improve nutrient efficiency, abiotic stress tolerance, or crop quality, regardless of their nutrient content. Chitin, found in the exoskeletons of crabs, shrimp, lobsters, and many parasites' cell walls, is the precursor to chitosan, a deacetylated form produced naturally and industrially. Over the years, chitosan has been developed for agricultural use to enhance tolerance to both biotic and abiotic stresses and improve traits related to primary and secondary plant metabolisms.

Seaweed extract is an organic biostimulant widely used in agriculture. Its application has been shown to increase crop yields, enhance nutrient absorption, improve resistance to frost and stress, boost seed germination, and reduce fungal and insect attacks (Kavipriya *et al*., 2011) [5] Humic acid and fulvic acid are natural components of soil organic matter formed by decomposing plants, animals, and microbes. Foliar application of humic acid has been reported to enhance photosynthesis, antioxidant activity, and water retention in plant leaves, promoting better plant growth and yield (El-Sawy *et al*., 2021) [2].

Hence, the present investigation was carried out to assess the effect of organic manures and biostimulants on ashwagandha's growth, yield, and quality (*Withania somnifera* (L.) Dunal).

2. Materials and Methods

A study on the effect of organic manures and biostimulants in crop growth and root characteristics of ashwagandha (*Withania somnifera* (L.) Dunal) was carried out at the Department of Agronomy, Kerala Agricultural University, Thrissur, Kerala, India during 2023 - 2024. The field was situated at 100 55' N latitude and 760 28' E longitude, at an altitude of 40 m above mean sea level. The soil was lateritic origin with a pH of 4.5 and electrical conductivity (EC) of 0.143 mS/m. The experiment followed a Factorial Randomized Block Design (FRBD) with 16 treatment combinations and three replications. The seeds of the Jawahar Ashwagandha - 20 (JA-20) variety released from Jawaharlal Nehru Krishi Vishwa Vidhyalaya (JNKVV) were used. The seedlings were raised in portrays and transplanted to the main field after 45 days with a plant spacing of 45 cm X 45 cm. The treatments included two factors: organic manures and biostimulants. The four levels of organic manures are A1: FYM @ 5 t/ha, A2: FYM @ 10 t/ha, A3: Vermicompost @ 2.5 t/ha, A4: Vermicompost @ 5 t/ha and the four levels of biostimulants are B1: Water spray (control), B2: Seaweed extract @ 0.4% at 1 and 3 MAP, B3: Humic and fulvic acid @ 0.4% @ 1 and 3 MAP, B4: Chitosan@ 0.1% at 1 and 3 MAP. At harvest, observations of plant height, number of branches per plant, and fresh and dry biomass per plant were taken. The days taken for 50 percent flowering were also recorded as an observation.

3. Results and Discussion

Plant height (cm) at harvest

At the harvest stage, a significantly higher plant height of 59.34 cm was observed in plants treated with vermicompost @ 5 t/ha compared to other treatments (Table 1). It was followed by FYM @ 10 t/ha (52.69 cm), vermicompost @ 2.5 t/ha (49.03 cm) and FYM @ 5 t/ha (48.99). Among various biostimulant treatments, plants sprayed with seaweed extract dominated with a height of 57.37 cm over the rest. The subsequent best treatment was the combination of humic and fulvic acid. The lowest was recorded by plants sprayed with chitosan (49.46 cm). Previous research has illustrated the benefits of organic supplements on plant development. Shravankumar *et al.* (2016) [13] observed significant improvements in ashwagandha plant height and growth following vermicompost application, attributed to enhanced micronutrient availability. Furthermore, Sasikala *et al.* (2016) [12] demonstrated that seaweed extract sprays promote tomato growth and height by providing essential nutrients and plant hormones.

Number of branches/plant

A significantly higher number of branches (Table 1) was noticed in plants applied with vermicompost @ 5 t/ha (13.79), followed by FYM @ 10 t/ha (13.20), FYM @ 5 t/ha (12.84) and vermicompost @ 2.5 t/ha (11.13). The spraying of seaweed extract produced a significantly higher number of branches per plant (16.51). In contrast, other biostimulant treatments like humic and fulvic acid (11.87), chitosan (11.39) and water sprayed (11.20) plants were on par with each other. The results are in close conformity with Manohar *et al.* (2012) [9].

Days to 50% flowering

Applying organic manures like vermicompost and FYM did not produce significant results on days of 50% flowering (Table 1). Meanwhile, water-sprayed plants took only 62.67 days to achieve 50% flowering, followed by seaweed extract (63.67 days). Plants treated with humic and fulvic acid took more days (66.83) to achieve 50% flowering. These findings support Khan *et al*.'s (2009) [6] observation that seaweed extract promotes early flowering.

Fresh biomass/plant (g)

Fresh biomass per plant (g) was observed at the harvest (Table 1). Significant higher values of fresh biomass per plant were noticed in plants fertilized with vermicompost @ 5 t/ha (141.35 g), which was on par with plants applied with FYM @ 10 t/ha (139.56 g), followed by vermicompost @ 2.5 t/ha (134.09 g) and FYM @ 5 t/ha (101.14 g). Among various biostimulant treatments, higher fresh biomass per plant was noticed in plants sprayed with seaweed extract (174.75 g). The lowest was registered in control plants (94.97 g). This might be due to the supply of primary nutrients like N, P and K at sufficient amounts by applying vermicompost, which favoured crop growth and produced higher fresh biomass per plant. Raja and Veerakumari (2013) [11] also reported similar findings in ashwagandha.

Dry biomass/plant (g)

Significantly higher dry biomass per plant was observed in plots applied with vermicompost @ 5 t/ha (53.98 g) followed by FYM @ 10 t/ha (51.53 g), vermicompost @ 2.5 t/ha (50.60 g) and FYM @ 5 t/ha (40.95 g). Besides, the plants sprayed with seaweed extract dominated other treatments with a dry biomass per plant of 64.15 g. The subsequent best treatment was humic and fulvic acid (47.98 g).

Fresh and dry weight of roots

The most important economic part of ashwagandha is the root. The direct effects of organic manures and biostimulants on fresh weight and dry weight of roots (g) are depicted in Table 1. Significantly higher fresh root weight per plant was observed in plants applied with vermicompost @ 5 t/ha (8.92 g) followed by FYM @ 10 t/ha (8.52 g), vermicompost @ 2.5 t/ha (8.35 g) and FYM @ 5 t/ha (6.73 g). A similar trend was followed in the case of dry root weight per plant with a maximum of 3.22 g when applied with vermicompost @ 5 t/ha. The next best treatment was FYM @ 10 t/ha (3.08 g). Seaweed extract-treated plants outperformed others regarding root fresh weight (11.84 g) and

dry weight (3.59 g). Pacheco *et al.* (2019) [10] reported that applying seaweed extract led to a 28.5% increase in root biomass in yarrow plants (*Achillea millefolium*) compared to control plots. The growth-promoting effect of seaweed extract is attributed to the presence of plant hormones such as auxin and cytokinin, which boost root yield. Additionally, seaweed extract contains vital macro and micronutrients necessary for both shoot and root development (Mafakheri and Asghari, 2018) [8].

Table 1: Effect of organic manures and biostimulants on plant height (cm), number of branches/plant, days to 50% flowering, fresh and dry biomass/plant (g), fresh and dry root yield/plant in ashwagandha.

Treatments	At harvest						
	Plant height (cm)	No. of branches/plant	Days to 50% flowering	Fresh biomass per plant (g)	Dry biomass per plant (g)	Fresh root yield/plant	Dry root yield/plant
Factor A: Organic manures							
FYM @ 5 t/ha	48.99	12.84	64.33	101.14	40.95	6.73	2.48
FYM @ 10 t/ha	52.69	13.20	65.17	139.56	51.53	8.52	3.08
Vermicompost @ 2.5 t/ha	49.03	11.13	65.42	134.09	50.60	8.35	2.75
Vermicompost @ 5 t/ha	59.34	13.79	64.42	141.35	53.98	8.92	3.22
S.E(m) ±	1.49	0.55	0.61	1.48	1.76	0.25	0.12
CD (0.05)	4.33	1.58	**NS**	4.27	5.07	0.73	0.35
Factor B: Biostimulants							
Water spray	49.58	11.20	62.67	94.97	41.03	6.95	2.63
Seaweed extract	57.37	16.51	63.67	174.75	64.15	11.84	3.59
Humic and fulvic acid	53.65	11.87	66.83	128.24	47.98	7.16	2.70
Chitosan	49.46	11.39	66.17	118.15	43.90	6.56	2.61
S.E(m) ±	1.49	0.55	0.61	1.48	1.76	0.25	0.12
CD (0.05)	4.33	1.58	1.77	4.27	5.07	0.73	0.35

4. Conclusion

The present investigation focused on applying organic manures and biostimulants and their effect on ashwagandha growth attributes and root yield. Results of this study revealed that basal application of vermicompost @ 5 t/ha exhibited significant enhancements in growth and root yield in ashwagandha. Consequently, seaweed extract spray @ 0.4% at 1 and 3 MAP produced significant results compared to other biostimulant treatments. Based on this study, we strongly recommend combining vermicompost and seaweed extract as organic nutrient management technology ashwagandha.

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