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Performance of ashwagandha (*Withania somnifera* L. Dunal) as influenced by integrated nutrient management practices and summer irrigation

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ABSTRACT

An experiment was conducted at the College of Agriculture, Padannakkad (Kerala) to study the effect of integrated nutrient management practices and summer irrigation on growth and root yield of Ashwagandha (Withania somnifera L. Dunal). The experiment was laid out in RBD with 14 treatments. The treatments were T1 - HDP in trenches mulched with polythene and filled with enriched growing medium, T2 - T1 + Recommended dose of NPK, T3 - T1 + Liquid organic manures, T4 - T2 + Azospirillum, T5 - T3 + Azospirillum, T6 - T4 + B and Mg, T7 - T5 + B and Mg, T8 - T6 + Summer irrigation at 15 mm CPE, T9 - T7 + Summer irrigation at 15 mm CPE, T10 - T6 + Summer irrigation at 30 mm CPE, T11 - T7 + Summer irrigation at 30 mm CPE, T12 - HDP in trenches filled with enriched growing medium, T13 - NRP in trenches filled with enriched growing medium, T14 - Broadcasting in trenches filled with enriched growing medium. The results revealed that high density planting of Azospirillum inoculated seedlings of Ashwagandha in trenches followed by basal dressing of recommended dose of NPK and, B and Mg application with summer irrigation at 30 mm CPE enhanced the growth and root yield and affected the highest benefit: cost ratio cultivation.

INTRODUCTION

Ashwagandha (*Withania somnifera* L. Dunal) also known as Indian ginseng, is a medicinal herb with multiple pharmacological properties. It is widely grown in dry parts of subtropical regions of India. All plant parts of ashwagandha have medicinal properties and are used in the preparation of various drugs; however, roots are mainly used for preparation of vital tonics. It is aphrodisiac tonic, a rasayan drug and a general tonic in arthritis and debility in old age. It is used in anxiety, depression, phobias, alcoholic paranoia, schizophrenia *etc*. The root of *W. somnifera* is a constituent of over 200 formulations in Ayruveda, Siddha and Unani medicines for the treatment of various physiological disorders. Only two species: of genus *Withania* namely, *W. somnifera* and *W. coagulans* are of economic and medicinal importance as they are widely used and extensively cultivated [6]. The

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medicinal properties of the plant are due to the presence of steroidal alkaloids and lactones commonly known as withanoloids. They have anticancer, antiinflamatory and hepatoprotective properties. Ashwagandha is a hardy and drought tolerant plant. The estimated production of its roots in India is more than 1500 tonnes, while the annual requirement is about 7000 tonnes, necessitating increase in its cultivation and higher production.

The high global interest in ashwagandha and the high demand for its root provide ample scope for its cultivation on commercial scale. But limited success has been achieved so far in increasing root yield mainly because of inadequate information on nutrient requirement and source of nutrients to be used for improving the growth, yield and quality. In this context, the present studyt was undertaken during 2015-17 at the College of Agriculture, Kerala Agricultural University, Padannakkad to evaluate the effect of integrated nutrient management practices and summer irrigation on growth and yield of ashwagandha root.

MATERIALS AND METHODS

The field experiment was conducted at the College of Agriculture, Padannakkad, during the summer season of 2015-2017. Jawahar Ashwagandha-134 (JA-134) was the variety selected for the trial. The experiment was replicated twice and laid out in RBD with 14 treatments. The treatments were T1 - HDP in trenches mulched with polythene and filled with enriched growing medium, T2 - T1 + Recommended dose of NPK, T3 - T1 + Liquid organic manures, T4 - T2 + azospirillum, T5 - T3 + azospirillum, T6 - T4 + B and Mg, T7 - T5 + B and Mg, T8 - T6 + Summer irrigation at 15 mm CPE, T9 - T7 + Summer irrigation at 15 mm CPE, T10 - T6 + Summer irrigation at 30 mm CPE, T11 - T7 + Summer irrigation at 30 mm CPE, T12 - HDP in trenches filled with enriched growing medium, T13 - NRP in trenches filled with enriched growing medium, T14 - Broadcasting in trenches filled with enriched growing medium. The plants were transplanted in trenches filled with FYM, coirpith compost and soil (1:1:1). Slurry of azospirillum culture was prepared by mixing 500 g culture with 50 ml water and the roots were dipped in the slurry for 15 – 20 minutes before transplanting. NPK fertilizers were given as basal application @ 40:40:40 kg ha^{-1} $year^{-1}$. Magnesium and boron were also given as basal application in the form of magnesium sulphate and borax @ 40 kg ha^{-1} and 5 kg ha^{-1} respectively. Three liquid organic manures, *viz.*, vermiwash, fermented plant juice and panchagavya were applied sequentially at monthly intervals starting from one month after transplanting. Vermiwash (10 %), fermented plant juice (5 %) and panchagavya (3 %) were given as foliar spray @ 500 L ha^{-1}. The crop was transplanted and harvested on January 1st and May 5th respectively.

RESULTS AND DISCUSSION

The data on growth and yield parameters of ashwagandha as influenced by integrated nutrient management practices and summer irrigation are presented in table 1, 2 and 3. The result has suggested that the treatments significantly influenced plant height at all stages of growth. The treatment T6 (HDP + NPK + *Azospirillum* +B + Mg) supported the highest plant height of 62.20 cm which was at par with T4, T7,T8, T9, T10, T11 and T13. The least (45.95 cm.) plant height was recorded in the control treatment (T14). Significant effect of treatments on functional leaf number was also observed throughout the period of crop growth. The treatment T6 (HDP + NPK + *Azospirillum* + B + Mg) afforded higher functional leaf number at 120 DAT. However, higher number of functional leaves was found at 75 DAT, the treatment T4 (HDP + NPK + *Azospirillum*) recorded the higher number of functional leaves which was at par with T3, T6 and T13 (Table 1). A matching trend was also visible with respect to leaf area. T6 (HDP + NPK + *Azospirillum* + B + Mg) recorded higher functional leaf number at 120 DAT. However, highest leaf area was found at 75 DAT, the treatment T4 (HDP + NPK + *Azospirillum*) recorded the highest leaf area of 1855.50 cm^2 which was at par with that of T13. The treatment did not exert any significant effect on primary branches at any of the growth stages. However, higher number of primary branches was recorded by T7 (HDP + LOM + *Azospirillum* + B + Mg).

Plant growth is influenced by the metabolic activities which needs sufficient amount of nutrients and water. Mulching the sides and bottom of trenches with polythene prevents the loss of nutrients and water through lateral movement and percolation beyond the root zone. So there is better conservation and efficient utilization of both rain and irrigation water and nutrients due to treatment effects which might have resulted in better plant growth in terms of morphological characters of ashwagandha in polythene mulched trenches combined with the application of *Azospirillum*, boron and magnesium. This could also be due to improved physical and chemical condition of soil and increased population of microorganisms by incorporation of organic manures which enhanced the uptake of nutrients which resulted in better plant growth. It has been reported that N, P and K nutrients have the largest effect on the physiology and yield of crops as they are essential for photosynthesis and dry matter production [2,8]. The observed positive effects of N and P application on the growth parameters of ashwagandha are in conformity with earlier workers [1,3,4,5].

Table 1: Effect of integrated nutrient management practices and summer irrigation on growth parameters of *W. somnifera* cv. JA-134

Treatments	Plant height (cm)	Number of functional leaves (75 DAT)	Leaf area at 75 DAT (cm^2)	Number of primary branches
T1	50.50	104.38	1252.50	6.25
T2	46.05	106.88	1282.50	4.50
T3	53.00	121.38	1456.50	5.50
T4	57.20	154.63	1855.50	5.25
T5	54.60	105.50	1266.00	5.13
T6	62.20	108.13	1297.50	4.25
T7	57.85	104.00	1248.00	6.88
T8	56.65	104.00	1248.00	3.88
T9	55.65	105.50	1266.00	5.13
T10	56.90	106.00	1272.00	4.63
T11	55.65	107.00	1284.00	6.00
T12	48.30	115.50	1386.00	3.63
T13	58.35	128.63	1543.50	5.50
T14	45.95	75.75	909.00	4.00
SEm (±)	2.22	9.02	108.27	0.85
CD (0.05)	6.787	27.558	330.669	NS

For treatments detail please refer to material & methods section

Table 2: Effect of integrated nutrient management practices and summer irrigation on root characters in *W. somnifera* cv. JA-134

Treatments	Number of primary root	Root length (cm)	Root volume (cm^3)	fresh root weight (g $plant^{-1}$)	Dry root weight (g $plant^{-1}$)
T1	7.25	28.50	6.65	11.00	5.48
T2	7.75	36.00	6.45	10.75	5.28
T3	7.50	33.75	5.85	9.75	4.87
T4	8.25	38.00	7.50	12.50	6.17
T5	8.00	38.00	7.70	12.80	6.23
T6	8.25	41.00	11.55	16.50	8.17
T7	8.00	40.10	11.20	15.90	7.85
T8	8.50	42.25	9.69	12.12	6.06
T9	8.75	41.10	11.54	14.43	7.22
T10	8.50	42.25	13.78	17.22	8.61
T11	8.50	41.50	13.49	16.86	8.43
T12	7.25	31.00	5.75	8.25	4.03
T13	7.25	30.50	10.50	15.00	7.38
T14	6.25	25.50	3.05	4.35	2.23
SEm (±)	0.33	0.81	0.62	0.90	0.44
CD (0.05)	0.987	2.472	1.880	2.729	1.336

Table 3: Effect of integrated nutrient management practices and summer irrigation on yield and cultivation economics of *W. somnifera* cv. JA-134

Treatments	Fresh root yield (kg ha^{-1})	Dry root yield (kg ha^{-1})	Seed yield (kg ha^{-1})	Benefit: Cost ratio
T1	880.00	438.40	304.00	1.83
T2	860.00	422.00	424.00	1.84
T3	780.00	389.60	400.00	1.66
T4	1000.00	493.20	492.00	2.15
T5	1024.00	498.40	400.00	2.03
T6	1320.00	653.60	540.00	2.71
T7	1272.00	628.00	500.00	2.51
T8	969.60	484.80	500.00	2.07
T9	1154.40	577.20	460.00	2.29
T10	1377.60	688.80	536.00	2.83
T11	1348.80	674.40	500.00	2.67
T12	660.00	322.00	336.00	1.69
T13	600.00	295.20	376.00	1.64
T14	696.00	356.00	360.00	2.06
SEm (±)	70.39	34.46	47.46	0.14
CD (0.05)	214.975	105.258	144.960	0.443

The treatment T9 (HDP + liquid organic manures (LOM) + *Azospirillum* + B + Mg + summer irrigation at 15 mm CPE) recorded higher number of primary root which was on par with that of T4, T5, T6, T7, T8, T10 and T11. The treatmentsT8 and T10 recorded greatest root length of 42.25 cm; T10 also recorded the highest root volume of 13.78 cm^3 fresh and dry root weight of 17.22g and 8.61 g per plant (Table 2). The remarkable influence of treatments on fresh and dry root production was observed at 120 DAT. The treatment T_{10} (HDP + NPK + azopirillum + B + Mg + summer irrigation at 30 mm CPE) recorded the highest fresh and dry root yield of 1377 and 688.8 kg ha^{-1} respectively. The lowest fresh and dry root yield of 600 and 295.2 kg ha^{-1} were recorded by T13 (NRP). Seed yield per hectare was also found to be significantly influenced by treatments. The treatment T6 (HDP + NPK + azospirillum + B + Mg) recorded the highest seed yield per hectare that was comparable with that in T10, T8, T11, T7, T4, T9, T2, T5 and T3. The comparative economics of different treatment combinations has revealed that, T10 (HDP + NPK + *Azospirillum* + B + Mg + summer irrigation at 30 mm CPE) along with T6, T11 and T7 registered the highest benefit cost ratio of 2.83 which was 42.40 per cent higher compared to T14. Similar to net income, T13 also showed the lowest benefit cost ratio (Table 3).

T10 (high density planting of *Azospirillum* inoculated seedlings of ashwagandha in trenches followed by basal dressing of recommended dose of NPK and B and Mg application with summer irrigation at 30 mm CPE) and T11 (high density planting of *Azospirillum* inoculated seedlings of ashwagandha in trenches followed by sequential application of liquid organic manure and B and Mg application with summer irrigation at 30 mm CPE) were very effective in promoting root proliferation. The enriched growing medium physically supports the root system and supply water, nutrients and oxygen. Enriched growing medium filled in the trenches consisted of a mixture of FYM, composted coir pith, leaf litter and soil which served as an excellent medium for efficient growth. The characteristics of the different component of the enriched growing medium have a catalytic effect in root growth promotion. It contains significant quantities of available nutrients, beneficial microorganisms, biologically active metabolites particularly gibberellins, auxins, cytokinin and group B vitamins. High surface area, low bulk density, low thermal conductivity and high porosity of coir pith make it a desirable component of the growing medium for enhancing the moisture holding capacity. There are several reports about its suitability for moisture conservation [7,9]. Azospirillum application by seedling dip method at the time of transplanting promoted root proliferation. There are many papers related to the screening and advantages of *Azospirillum* particularly in rice, maize and sugarcane but a few on ashwagandha.

This investigation clearly indicated that T10 was found worthwhile for popularization with respect to higher fresh and dry root yield per plant and root production per hectare and benefit cost ratio.

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