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Effect of Organic Manures and Bio-Inoculants on Growth, Dry Root Yield and Quality in Ashwagandha (*Withania somnifera* L. Dunal.)

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A B S T R A C T

An investigation was carried out to study the effect of organic manures and bio-inoculants (Azatobacter, Azospirillum, PSB and VAM) on growth, yield and quality of ashwagandha by comparing with RDF at K.R.C.C.H. College of Arabhavi. The results showed that growth parameters viz., plant height (74.20 cm), stem diameter (0.85 cm), plant spread (N-S (37.60 cm) and E-W (38.07 cm)) and number of primary branches (8.80) recorded maximum with the application of RDF + VAM and yield parameters viz., number of berries per plant (219.33), seed yield (3.15 q/ha), fresh root (19.58 q/ha) and dry root yield (5.88 q/ha) recorded maximum with the application of RDF + VAM, however the organic treatment T_7 have shown on par results in growth and yield parameters.

Introduction

Ashwagandha or Asgandh (*Withania somnifera* L. Dunal.) popularly known as 'Indian Ginseng' belongs to the family Solanaceae. It is found in wild state in the Mediterranean region of North Africa. In India it is mainly cultivated in Mandsaur district of Madhya Pradesh, adjoining villages of Kota district of Rajasthan, Punjab and Karnataka. Ashwagandha roots and occasionally its leaf and seeds are used in ayurvedic and unani medicines preparations (Majumdar, 1955). The total alkaloid content of the Indian ashwagandha roots is reported to vary between 0.13 to 0.31 per cent. Apart from roots, alkaloids have also been reported in leaves and berries (Sreerekha *et al.,* 2004). The roots are prescribed in medicines for hiccup, several female disorders, bronchitis, rheumatism, dropsy and stomach, lung inflammation and skin diseases. They are mostly used for curing general and sexual disabilities. Roots are having anti-aging property (Savitha *et al.*,

2009). The leaves are used to cure eye boils, and swellings of hands and feet, in treatment of syphilis, to kill the lice infecting the body. The leaf decoction is used for treatment of haemorrhoids and arthritis.

Materials and Methods

The field experiment was carried out in the division of plantation, Spices, Medicinal and Aromatic Crops, college of horticulture, Arabhavi during 2016-2017. The experiment was laid out in randomized block design with 7 treatments *viz.*,T_1 -Recommended dose of fertilizers (N: P: K- 40:50:40 kg/ha) + FYM (5 t/ha), T_2- FYM (5 t/ha) + Vermicompost-1.33 t/ha (N equivalent weight), T_3-T_1 + VAM (25 kg/ha), T_4- FYM (5 t/ha) + VAM (25 kg/ha), T_5- FYM (5 t/ha) + VAM (25 kg/ha) + (Panchagavya-3% + Amruthapani-3% at 15 days' interval up to harvest crop), T_6 -FYM (5 t/ha) + Azotobacter (625 g/ha) + Azospirillum (625 g/ha) + PSB (625 g/ha) + VAM (25 kg/ha) and T_7- T_6 + (Panchagavya-3% + Amruthapani-3% at 15 days' interval up to harvest of crop) and 3 replications. The spacing followed was 30 x 20 cm.

The effect of organic manures and bio-inoculants on growth, yield of asgwagandha are summarized in the Table 1 and 2.

Results and Discussion

Maximum plant height, stem diameter, plant spread (N-S & E-W) and number of primary branches (74.20 cm, 0.85 cm, (37.60 cm, 38.07 cm) and 8.80, respectively), were recorded in the treatment T_3 -Recommended dose of fertilizers (N:P:K- 40:50:40 kg/ha) + FYM (5t/ha) + VAM (25 kg/ha), which was on par with T_1 (68.53 cm, 0.84 cm, (35.07 cm and 36.67 cm) and 8.40, respectively), T_7 (67.67 cm, 0.84 cm, (35.00 cm and 37.00 cm) and 8.20, respectively) and T_5 (63.47 cm, 0.83 cm, (34.27 cm and 33.00 cm) and 8.13, respectively). This increasing trend in morphological parameters might be due to recommended dose of fertilizer along with VAM recorded significantly higher values for morphological parameters. It could be attributed to the quick and readily availability of major nutrients like N, P and K to plants at earlier stages of plant growth. The results obtained in the present investigation are in agreement with earlier findings of Rana *et al.*, (2005), Snezana *et al.*, (2012) in buckwheat and Shinde *et al.*, (2013) in ashwagandha.

However the organic treatment T_7 -FYM (5 t/ha) + Azotobacter (625 g/ha) + Azospirillum (625 g/ha) + PSB (625 g/ha) + VAM (25 kg/ha)+ (Panchagavya-3% + Amruthapani-3% at 15 days interval) has also shown better result, this might be due to the reason that, their built up in the beneficial soil microbial population at the rhizosphere and regular addition of bio-formulations especially by the synergetic effect drench both of panchagavya and amrutpani have lead to the effective supply of nutrients and acting as source of PGPR (Plant Growth Promoting Rhizobacteria). This had helped to improve nutrient availability to the plants and also by arbuscular mycorrhizal fungi, due to their ability to increase nutrient uptake and water transport. The results obtained in the present investigation are in agreement with earlier findings of Sakhubai *et al.*, (2014) in buckwheat, Ravikumar *et al.*, (2012) in coleus and Vajantha *et al.*, (2014) in ashwagandha.

Number of berries per node and seed yield was significantly influenced by application of organic manures and bio-inoculants (Table 2). At harvest, maximum number of berries per plant (219.33) was recorded in T_3-Recommended dose of fertilizers (N:P:K-40:50:40 kg/ha) + FYM (5 t/ha) + VAM (25 kg/ha), it was on par with T_1 (213.33/plant), T_7 (211.67/plant) and T_5 (210.13/plant). There was appreciable increase in the number of

berries per plant due to excellent growth and development of root and shoot particularly more assimilatory area on account of balanced and timely supply of all the essential nutrients which in turn led to better partitioning of photosynthates from source to the sink (seeds). Similar results has been reported by Shrivatsav and Sahu (2013) in ashwagandha.

Seed yield was influenced with application of organic manures and bio-inoculants (Table 2). At harvest maximum seed yield (2.83 g/plant, 0.23 kg/plot and 3.15 q/ha) was obtained in T_3-Recommended dose of fertilizers (N:P:K-40:50:40 kg/ha) + FYM (5 t/ha) + VAM (25 kg/ha), it was on par with T_1 (2.78 g/plant, 0.22 kg/plot and 3.09 q/ha) and T_7 (2.73 g/plant, 0.22 kg/plot and 3.0 q/ha).

The enhanced seed yield in particular treatment might be due to availability of nutrients in the soil throughout the growing phase and also due to enhanced carbohydrates synthesis and effective translocation of the photosynthates to the sink and the results are in line with the findings of with Pakkiyanthan *et al.*, (2004), Panchabhai *et al.*, (2005) in ashwagandha. Immediate supply of plant nutrients by inorganic sources has enhanced seed yield were realized.

Table.1 Growth of ashwagandha at 150 Days After Sowing

Treatments	Plant height (cm)	Stem diameter (cm)	Plant spread		Number of primary branches
			(N-S) (cm)	(E-W) (cm)	
T_1-Recommended dose of fertilizers (control) N:P:K-40:50:40 kg per ha + FYM-5 t/ha	68.53	0.84	35.07	36.67	8.40
T_2- FYM (5 t/ha) +Vermicompost-1.33 t/ha (N equivalent weight)	54.53	0.73	24.33	25.13	7.27
T_3- T_1 +VAM (25 kg/ha)	74.20	0.85	37.60	38.07	8.80
T_4-FYM (5 t/ha) + VAM (25 kg/ha)	56.07	0.78	29.20	28.13	7.53
T_5- FYM (5 t/ha) +VAM (25 kg/ha) + (Panchagavya -3% + Amruthapani -3% at 15 days interval)	63.47	0.83	34.27	33.00	8.13
T_6- FYM (5 t/ha) + Azotobacter (625 g/ha) + Azospirillum (625 g/ha) + PSB (625 g/ha) + VAM (25 kg/ha)	59.40	0.82	34.00	29.07	8.07
T_7-T_6+ (Panchagavya -3% + Amruthapani -3% at 15 days interval)	67.67	0.84	35.00	37.00	8.20
Mean	**63.41**	**0.81**	**32.78**	**32.44**	**8.06**
SEm ±	**1.32**	**0.02**	**2.51**	**2.67**	**0.25**
CD at 5%	**4.08**	**0.06**	**7.74**	**8.23**	**0.78**

Table.2 Yield of ashwagandha at after harvest

Treatments	Number of berries/plant	Seed yield (q/ha)	Fresh root yield (q/ha)	Dry root yield (q/ha)
T_1-Recommended dose of fertilizers (control) N:P:K- 40:50:40 kg per ha + FYM-5 t/ha	213.33	3.09	19.50	5.27
T_2- FYM (5 t/ha) +Vermicompost-1.33 t/ha (N equivalent weight)	183.87	2.25	15.87	4.21
T_3- T_1 +VAM (25 kg/ha)	219.33	3.15	19.58	5.88
T_4-FYM (5 t/ha) + VAM (25 kg/ha)	192.33	2.38	17.03	4.41
T_5- FYM (5 t/ha) +VAM (25 kg/ha) + (Panchagavya -3% + Amruthapani -3% at 15 days interval)	210.13	2.71	19.12	4.72
T_6- FYM (5 t/ha) + Azotobacter (625 g/ha) + Azospirillum (625 g/ha) + PSB (625 g/ha) + VAM (25 kg/ha)	208.67	2.45	18.61	4.58
T_7-T_6+ (Panchagavya -3% + Amruthapani -3% at 15 daysinterval)	211.67	3.03	19.49	5.00
Mean	**205.62**	**2.72**	**18.46**	**4.85**
SEm ±	**3.49**	**0.13**	**0.71**	**0.32**
CD at 5%	**10.74**	**0.40**	**2.18**	**0.97**

Fresh and dry root yield was significantly influenced by the application of organic manures and bio-inoculants in ashwagandha. At harvest fresh and dry root yield were significantly influenced by treatments. The highest fresh root yield (17.60 g/plant, 1.41 kg/plot and 19.58 q/ha) was recorded in T_3-Recommended dose of fertilizers (N:P:K-40:50:40 kg/ha) + FYM (5 t/ha) + VAM (25 kg/ha), it was on par with T_1 (17.55 g/plant, 1.40 kg/plot and 19.50 q/ha), T_7 (17.54 g/plant, 1.40 kg/plot and 19.49 q/ha), T_5 (17.25 g/plant, 1.38 kg/plot and 19.12 q/ha) and T_6 (16.77 g/plant, 1.34 kg/plot and 18.61 q/ha) recorded. Highest dry root yield (5.29 g/plant, 0.42 kg/plot and 5.88 q/ha) recorded in T_3-Recommended dose of fertilizers (N:P:K- 40:50:40 kg/ha) + FYM (5 t/ha) + VAM (25 kg/ha) it was on par with T_1 (4.75 g/plant, 0.38 kg/plot and 5.27 q/ha) and T_7 (4.69 g/plant, 0.36 kg/plot and 5.00 q/ha).

The combined application of inorganic fertilizer and organic manures (FYM) might have supplied adequate amount of nutrients, favoured metabolic rate, auxin activities in the plant, resulting in better yield attributes and higher root yield. These results are in agreement with Maheshwari *et al.,* (2000), Ajay *et al.,* (2005) in ashwagandha and Somanath *et al.,* (2005) in coleus. The VAM fungus and bio-formulations, increased root geometry, nutrient access and supply resulting in the development of sound and healthy rhizosphere with increased extramycelial hyphae might had further contributed to improved growth resulting in increased nutrient uptake, photosynthesis and excellent biochemical activities. Similar results were also reported Sakhubai *et al.,* (2014) in buckwheat and Ravikumar *et al.,* (2010) in coleus, Vajantha *et al.,* (2014) in ashwagandha.

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