Int.J.Curr.Microbiol.App.Sci (2019) *8*(4): 1893-1899

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 8 Number 04 (2019)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2019.804.222

Studies on Substitution of Inorganic Fertilizers for Organic and Biological Fertilizers in Ashwagandha (*Withania somnifera* Dunal.) Production

R. Praveen[1*], N. Hari Prasad Rao[2] and G. Sathyanarayana Reddy[3]

[1]College of Horticulture, Venkataramannagudem, Dr Y.S.R Horticultural University, Andhra Pradesh, India
[2]College of Horticulture, Rajendranagar, Dr Y.S.R Horticultural University, Andhra Pradesh, India
[3]Herbal garden, Rajendranagar, Dr Y.S.R Horticultural University, Andhra Pradesh, India

**Corresponding author*

Keywords

Yield, Quality, Economics, Alkaloids, Green manure

Article Info

Accepted:
15 March 2019
Available Online:
10 April 2019

A B S T R A C T

A field experiment was conducted at College of Horticulture, Venkataramannagudem, West Godavari district, Andhra Pradesh during late kharif season of 2010 with an objective to evaluate the package of organic and biological sources of nutrients vis-à-vis inorganic fertilizers on yield, quality and economics of ashwagandha. The experiment was laid out in randomized block design with fourteen treatments replicated thrice. The treatments consisted of nutrients from different organic sources *Viz.,* Neem cake, vermicompost, poultry manure, farm yard manure, sunnhemp *in situ* green manure, biological sources *viz., Azospirillum* + PSB alone and in combination with organic sources of nutrients and inorganic sources *viz.,* recommended dose of fertilizers (N P K at 40:60:20 kg ha^{-1}) and 50 % recommended dose of fertilizers (N P K at 20:30:10 kg ha^{-1}). The study revealed that application of Poultry manure + Biofertilizers (Azospirillum + PSB) produced longest roots (21.00 cm) with widest diameter (1.59 cm) but was on par with vermicompost + biofertilizers and recommended dose of inorganic fertilizers. The same treatment i.e., Poultry manure + Biofertilizers recorded maximum fresh root (1524 kg ha^{-1}), dry root (739 Kg ha^{-1}) and seed yield (186.4 kg ha^{-1}) but was on par with vermicompost + biofertilizers and recommended dose of inorganic fertilizers. Similar trend was observed in respect of total alkaloid content of roots. The treatment poultry manure + Biofertilizers also recorded maximum gross (Rs 96,202) and net income (Rs 72,252) but B:C ratio was maximum in recommended dose of fertilizers (3.12) followed by Poultry manure + Biofertilizers. Thus, Poultry manure + Biofertilizers with overall better performance and economic advantage over other treatments can be recommended for complete substitution of inorganic fertilizers in ashwagandha.

Introduction

Ashwagandha (*Withania somnifera* Dunal.) popularly known as "Indian ginseng" is an important cultivated medicinal plant of India. The root of the plant is mainly used in ayurvedic and unani preparations. The pharmacological activity of roots is attributed

to the presence of alkaloids with anine and somniferine. It is used as an antistress, immunomodulatory, anticancer, antioxidant, anti arthritic, antidepressant, diuretic, hypocholestraemic and adaptogenic. In the last 40-50 years farmers are heavily dependence on inorganic fertilizers to maximize crop yields resulted in negative change in soil physical and chemical properties. In the changing scenario, the technology based primarily on continuous use of chemical inputs with only a meagre supplementation of organic manures is thought to be not sustainable since the productivity of soils is fast deteriorating. In international trade, the herbal medicines and products produced through organic forms command premium price and in much demand. Therefore, farmers are searching for alternatives to replace the chemical fertilizers by production and use of organic manures and biofertilizers. Since, very limited systematic research efforts have been made to optimize the organic sources of nutrients to enhance the productivity and quality, the present experiment was carried out to study the productivity, quality and economics of ashwagandha as influenced by organic and bionutrition.

Materials and Methods

A field experiment was conducted during late *Kharif* season of 2010 at College of Horticulture, Venkataramannagudem, West Godavari Dist (Andhra Pradesh) under irrigated conditions. The soil of the experimental site was sandy loam in texture, neutral in reaction, low in organic carbon, low in available nitrogen (192 kg/ha), high in available phosphorus (28.5 kg/ha) and medium in available potassium (255 kg/ha) . The studies were carried out using ashwagandha cv. Poshita with 14 treatments *viz.*, neem cake 4 t ha^{-1} (NC 4 t ha^{-1}: T_1), vermicompost 5 t ha^{-1}(VC 5 t ha^{-1}: T_2), poultry manure 5 t ha^{-1} (PM 5 t ha^{-1}: T_3), farm yard manure 12 t ha^{-1} (FYM 12 t $ha^{-1:}$ T_4), *insitu* green manuring with sunnhemp (GM: T_5), NC 4 t ha^{-1} + BF (T_6), VC 5 t ha^{-1} + BF (T_7), PM 5 t ha^{-1} + BF (T_8), FYM 12 t ha^{-1} + BF (T_9), GM + BF (T_{10}), bio-fertilizers consisting of *Azospirillum* and Phosphate solubilizing bacteria (BF: T_{11}), recommended dose of fertilizers (RDF: T_{12}), 50 per cent recommended dose of fertilizers (50 per cent RDF: T_{13}) and control (T_{14}). The experiment was laid out in a randomized block design with three replications. Sunnhemp seeds were broadcasted at 40 kg ha^{-1} and it was incorporated at the age of 53 days by tractor drawn rotavator and left for ten days to decompose. The organic manures were applied as per the treatments and incorporated into the soil a week before seed sowing. The biofertilizers *Azospirillum lipoferum* (strain ICM 1001) and phosphate solubilising bacteria (*Bacillus meghatherium* var phosphaticum) @ 5 kg ha^{-1} each were soil and seed inoculated. The crop was sown at 30x10cm spacing. The crop was sprayed with neem oil @ 4 ml per litre against leaf eating insects. The crop was harvested at 180 DAS. Data were recorded on root length and root diameter per plant in cm from randomly selected five plants from each replication. The plants from each net plot were uprooted at harvest the roots were separated and dried under sun. The fresh and dry root yield was recorded and expressed in kg per hectare. Total Alkaloid content was estimated by using method given by Mishra, 1989. The prices of all the inputs, labour cost, dry root yield and seed yield that were prevailing at the time of their use were taken into consideration for calculating cost of cultivation, gross income, net income and benefit: cost ratio. The data collected were statistically analysed for interpretation following the procedure outlined by Panse and Sukhatme (1970).

Results and Discussion

The main yield attributes in ashwagandha are root length and root diameter. The results indicated that application of PM 5 t ha^{-1} + BF produced the longest roots (21.00 cm) with widest diameter (1.59 cm) but was on par with VC 5 t ha^{-1} + BF and RDF (Table 1). The higher values of yield attributes of ashwagandha were mainly due to better growth of the plant which can be related to higher values of growth parameters recorded at harvest. The results corroborate the findings of Jayalakshmi (2003) in coleus.

Root yield and quality

At harvest, the combination of PM 5 t ha^{-1} + BF produced the highest fresh root yield (1524 kg ha^{-1}), dry root yield (739 kg ha^{-1}), alkaloid content (0.33 %) and alkaloid yield (2.45 kg ha^{-1}) but was on par with VC 5 t ha^{-1} + BF and RDF (Table 1). The maximum root yield observed in the plants may possibly be due to increased length and diameter of roots. The increase in fresh and dry root yield may be attributed to availability of more nutrients continuously through poultry manure over a long period and biofertilizer inoculation thus favouring the growth and development of better root system resulting in better uptake of nutrients. Similar results were also reported with poultry manure + *Azospirillum* (2 kg/ha) + phosphobacteria (2 kg/ha) in Bhumyamalaki (Chezhiyan *et al.,* 2003). The alkaloids being the products of nitrogen metabolism, the production of alkaloids is directly related to nitrogen supply to the plants. Thus higher availability of nitrogen through poultry manure, vermicompost and *Azospirillum* might have played an important role in biosynthesis and accumulation of alkaloid (Waller and Nowacki, 1978). Similar results were reported by Vijayabharati (2002) in ashwagandha. Further the same treatments had also recorded higher total alkaloid yield per ha and were on par with each other. The higher total alkaloid yield was attributed to higher total alkaloid content in roots and higher root yield of ashwagandha. The treatments, PM 5 t ha^{-1} + BF had recorded yield attributes, yield and alkaloid content on par with VC 5 t ha^{-1} + BF and RDF indicating the scope for complete substitution of inorganic fertilizers with these treatments in ashwagandha. Similar findings were also reported by Vennila *et al.,* (2008) in coleus and Haruna *et al.,* (2009) in roselle.

The organic treatments with a combination of biofertilizers *Viz.*, NC + BF, VC + BF, PM + BF, FYM + BF and GM + BF had recorded yield attributes, yield and quality parameters significantly higher than organic treatments (NC, PM, VC, FYM and GM) alone indicating the need of biofertilizers for improving yield attributes and yield. Similar findings with combination of Vermicompost and biofertilizers in mint (Suresh *et al.,* 2008), poultry manure and biofertilizers in Bhumyamalaki (Chezhiyan *et al.,* 2003), neem cake and biofertilizers in *Brassica juncea* (Irfan Khan *et al.,* 2010), FYM and biofertilizers in turmeric (Mohapatra and Das 2009), green manuring and biofertilizers in senna (Rao, 2008) were also reported.

Further, the treatment with *Azospirillum* + PSB (BF) had recorded yield attributes and yields on par with 50 per cent RDF offering an opportunity of reducing inorganic fertilizers by 50 per cent with the inoculation of these biofertilizers in ashwagandha.

The synergistic interaction among the inoculated microbes might have enhanced the activity of nitrogen fixation, phophorus availability and production of growth promoting substances (Anandan, 2000) leading to the fresh and dry root yields on par with 50 percent RDF. Gopal and Paramaguru (2006) in senna also reported similar findings.

Table.1 Root yield attributes, root yield parameters and quality parameters as influenced by organic manures and their combination with biofertilizers in ashwagandha

Treatments	Root length (cm)	Root Diameter (cm)	Fresh root yield (kg ha^{-1})	Dry root yield (kg ha^{-1})	Alkaloid content (%)	Alkaloid yield (Kg ha^{-1})
T1: NC 4 t ha^{-1}	16.12	1.07	1150	540	0.28	1.55
T_2: VC 5 t ha^{-1}	17.40	1.20	1247	592	0.29	1.74
T_3: PM 5 t ha^{-1}	17.56	1.24	1289	612	0.29	1.78
T_4: FM 12t ha^{-1}	16.10	1.05	1134	532	0.28	1.52
T_5: GM	15.86	1.04	1121	526	0.27	1.42
T_6: Neem cake 4 t ha^{-1} + BF	19.03	1.32	1411	677	0.29	2.00
T_7: vermicompost 5 t ha^{-1} + BF	20.70	1.52	1484	719	0.33	2.37
T_8: Poultry manure 5 t ha^{-1} + BF	21.00	1.59	1524	739	0.33	2.45
T_9: Farm yard manure 12t ha^{-1} + BF	18.76	1.29	1348	647	0.29	1.90
T_{10}: Green manure (*Crotolaria juncea*) + BF	18.46	1.26	1295	621	0.28	1.74
T_{11}: *Azospirillum* 5 kg ha^{-1} + PSB 5 kg ha^{-1} (BF)	14.20	0.83	1049	487	0.23	1.12
T_{12}: 100% RDF	20.00	1.48	1473	714	0.31	2.21
T_{13}: 50% RDF	14.73	0.89	1054	490	0.23	1.15
T_{14}: Absolute control	13.13	0.71	0984	447	0.20	0.89
Mean	17.36	1.17	1254.5	595.92	0.278	1.700
SEm ±	0.430	0.05	21.00	9.50	0.015	0.090
CD (0.05)	1.260	0.14	62.00	27.8	0.030	0.250

Table.2 Cost of cultivation (Rs ha^{-1}), gross income (Rs ha^{-1}), net income (Rs ha^{-1}) and benefit cost ratio (BCR) as influenced by different organic manures and their combination with biofertilizers in ashwagandha

Treatments	Root yield (Kg ha^{-1})	Cost of root yield (Rs ha^{-1})	Seed yield (Kg ha^{-1})	Cost of Seed (Rs ha^{-1})	Cost of production (Rs)	Gross income (Rs)	Net income (Rs)	B:C ratio
T1: NC 4 t ha^{-1}	540	59400	154.60	12368	34450	71768	37318	1.08
T_2: VC 5 t ha^{-1}	592	65120	159.16	12733	32950	77853	44903	1.36
T_3: PM 5 t ha^{-1}	612	67320	160.43	12834	23450	80154	56704	2.42
T_4: FM 12t ha^{-1}	532	58520	143.30	11464	26450	69984	43534	1.64
T_5: GM	526	57860	141.26	11301	23150	69161	46011	1.99
T_6: Neem cake 4 t ha^{-1} + BF	677	74470	176.36	14109	34950	88579	53629	1.53
T_7: vermicompost 5 t ha^{-1} + BF	719	79090	184.60	14768	33450	93858	60408	1.80
T_8: Poultry manure 5 t ha^{-1} + BF	739	81290	186.40	14912	23950	96202	72252	3.02
T_9: Farm yard manure 12t ha^{-1} + BF	647	71170	174.40	13952	26950	85122	58172	2.16
T_{10}: Green manure (*Crotolaria juncea*) + BF	621	68310	171.50	13720	23650	82030	58380	2.47
T_{11}: *Azospirillum* 5 kg ha^{-1} + PSB 5 kg ha^{-1} (BF)	487	53570	134.60	10768	20950	64338	43388	2.07
T_{12}: 100% RDF	714	78540	183.36	14669	22607	93209	70602	3.12
T_{13}: 50% RDF	490	53900	135.03	10802	21528	64702	43174	2.00
T_{14}: Absolute control	447	49170	113.60	9088	20450	58258	37808	1.85

Note: Cost of Dry root @ Rs 110 per kg and Seed @ Rs 80 per kg.

The yield attributes, yield and quality parameters recorded with control were, however, the lowest at harvest.

Economics

Higher gross income were obtained with the treatments, PM 5 t ha^{-1} + BF (Rs 96202/-) and VC 5 t ha^{-1} + BF (Rs 93858/-) compared to RDF (Rs 93209/-) owing to higher yield recorded with the treatments (Table 2). Further the treatments with neem cake component were observed with higher cost of cultivation owing to high cost of neem cake resulting in lower net income and BCR. The treatment, RDF had recorded the maximum BCR (3.12) followed by PM 5 t ha^{-1} + BF (3.02) and GM + BF (2.47).

In conclusion, the treatment, poultry manure 5 t ha^{-1} + BF with overall better performance and economic advantage over other organic treatments can be recommended for complete substitution of inorganic fertilizers in ashwagandha. The treatment, biofertilizers containing *Azospirillum* and PSB can be recommended for reducing quantity of inorganic fertilizers and also to improve soil biological properties.

Acknowledgment

Thanks to my chairman Dr. N. Hari Prasad Rao and Dr. D.V. Swami for their inspiring guidance, valuable and technical advice.

References

Anandan, M 2000 An integrated approach of biofertilizer for sustainable agriculture. Intensive Agriculture 38 (1-2): 9-11.

Chezhiyan, N., Saraswathy, S. and Vasumathi, R. 2003. Studies on organic manures, biofertilizers and plant density on growth, yield and alkaloid content of Bhumyamalaki (*Phyllanthus amarus* Schum. and Tonn.). South Indian Hort. 51: 16.

Gopal, N O and Paramaguru P 2006 Synergistic interaction of *Azospirillum* and phosphorus solubilizing bacteria for enhancing the growth, yield and rhizosphere microbial dynamics of the senna (*Cassia angustifolia* Vahl.). In: Book of abstracts on International conference on Globalization of Traditional, Complementary and Alternative Systems of Medicine, TNAU, Coimbatore, March 16-18, Poster abstract, 25:28.

Haruna, Ibrahim, I. M. and Rahman, H. S. A. 2009. The yield and profitability of roselle (*Hibiscus sabdariffa* L.) at varying poultry manure and nitrogen fertilizer rates in the Southern guinea Savanna of Nigeria. Electronic J. Environmental Agri. Food chemistry. 8: 11, 1136-1139.

Irfan khan, aquil Ahmed, Anwar and Masood. 2010. Effect of *Azospirillum* inoculation and organic manures on *Brassica juncea* (L.) Czern and Coss. Intl. J. Plant. Sci. 5: 2, 699-671.

Jayalakshmi, S. 2003. Effect of spacing and nitrogen levels on growth, tuberous root yield and alkaloid content of medicinal coleus (*Coleus forskohlii* Brig.). M.Sc. Thesis, Tamil Nadu Agricultural University, Coimbatore.

Mishra, S. N. 1989. Analytical methods for analysis of total alkaloids in roots of *Withania spp*. Proc. All India Workshop on Medicinal and Aromatic plants. Faizabad, 4-7 December. P. 492-495.

Mohapatra, S. C. and Das, T. K. 2009. Integrated effect of biofertilizers and organic manures on turmeric (*curcuma longa*). Environment and Ecology. 27:3, 1444-1445.

Panse, V G and Sukhatme P V 1978

Statistical methods for agricultural workers. Indian Council of Agricultural Research, New Delhi. pp: 359.

Rao, H. P. N. 2008. Studies on the effect of organic and bionutrient sources on growth, yield and quality in senna (*Cassia angustifolia* Vahl.) and their residual effect on succeeding roselle (*Hibiscus sabdariffa* L.) crop. Ph.D. Thesis, Acharya N. G. Ranga Agriculturral University, Hyderabad.

Suresh, M., Sridevi, P. and Ashok, L. 2008. Effect of vermicompost, FYM and their combination with biofertilizers on Ashwagandha. Abstracts 95th Indian Science Congress. P. 98-101.

Vennila, C. and Jayanthi, C. 2008. Nutrient use pattern and available nutrient balance as influenced by sources of nutrients in medicinal Coleus. J. Farming Systems Res. Development. 14: 1, 73-77.

Vijayabharati, J. A. N. 2002. Integrated nutrient management of ashwagandha for growth, yield and quality. M.Sc. (Hort.) Thesis, Tamil Nadu Agricultural University, Madurai.

Waller, G. R. and Nowacki, E. K. 1978. Alkaloid biology and Metabolism in Plants. Plenum Press, New York.

How to cite this article:

Praveen, R., N. Hari Prasad Rao and Sathyanarayana Reddy, G. 2019. Studies on Substitution of Inorganic Fertilizers for Organic and Biological Fertilizers in Ashwagandha (*Withania somnifera* Dunal.) Production. *Int.J.Curr.Microbiol.App.Sci.* 8(04): 1893-1899.
doi: https://doi.org/10.20546/ijcmas.2019.804.222