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Effect of Different Organic Sources of Nutrients on Quality and Economics of Ashwagandha [*Withania somnifera* (L.) Dunal]

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present investigation entitled Effect of different organic sources of nutrients on quality and economics of ashwagandha [*Withania somnifera* (L.) Dunal] was carried out during *Kharif* 2021-22 at College Farm, College of Horticulture, Sardarkrushinagar Dantiwada Agricultural University, Jagudan, Dist. Mehsana, Gujarat. Experiment was laid out in randomized block design with three replications and twenty treatments *viz*., T_1: 100% RDN through FYM; T_2: 100% RDN through Vermicompost; T_3: 100% RDN through Neem cake; T_4: 100% RDN through Poultry manure; T_5:

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80% RDN through FYM; T_6: 80% RDN through Vermicompost; T_7: 80% RDN through Neem cake; T_8: 80% RDN through Poultry manure; T_9: 60% RDN through FYM; T_{10}: 60% RDN through Vermicompost; T_{11}: 60% RDN through Neem cake; T_{12}: 60% RDN through Poultry manure; T_{13}: 80% RDN through FYM + *Azotobacter* + KSM + PSB; T_{14}: 80% RDN through Vermicompost + *Azotobacter* + KSM + PSB; T_{15}: 80% RDN through Neem cake+ *Azotobacter* + KSM + PSB; T_{16}: 80% RDN through Poultry manure + *Azotobacter* + KSM + PSB; T_{17}: 60% RDN through FYM + *Azotobacter* + KSM + PSB; T_{18}: 60% RDN through Vermicompost + *Azotobacter* + KSM + PSB; T_{19}: 60% RDN through Neem cake + *Azotobacter* + KSM + PSB; T_{20}: 60% RDN through Poultry manure + *Azotobacter* + KSM + PSB.
Maximum chlorophyll a, b and total at 90 DAS (at full bloom stage) (1.92, 0.75 and 2.11 mg/g, respectively) and withanolides content (0.32%) at harvest were recorded with treatment $T_{16.}$ The maximum net income (₹1,38,707/ha) and benefit cost ratio (3.52) were also obtained in same treatment. Therefore, it can be concluded that the application of 80% RDN through poultry manure + *Azotobacter* + KSM + PSB (T_{16}) was found beneficial for obtaining higher yield of better quality and economic returns in ashwagandha.

Keywords: Azotobacter; FYM; KSM; neem cake; poultry manure; PSB; RDN; vermicompost.

1. INTRODUCTION

Ashwagandha [*Withania somnifera* (L.) Dunal] commonly known as asgandh is one of the most important medicinal plants that belongs to family solanaceae. Ashwagandha roots and occasionally its leaves are used in *Ayurvedic* and *Unani* medicines [1]. The pharmacogical activity of the roots are attributed due to presence of several alkaloids (about 13), out of which withanine (about 38 % of total alkaloids) and somniferine are most important. These alkaloids are collectively called as total alkaloids, which are about 0.4 to 0.8 % of dry root weight. Its roots and paste of green leaves are used to relieve joint pain and inflammation. It is also an ingredient of medicaments prescribed for curing disability and sexual weakness. Warm leaves are used for providing comfort in eye disease [1].

The quality of the raw herbal drug or medicinal herb is the major concern regarding export in international market. One of the major factors contributing to the poor quality of the medicinal herb is represented by their residues and contaminants. These residues (pesticides and other synthetic chemicals) and contaminants (heavy metals) can accumulate during cultivation of medicinal herbs and may have adverse effects on the consumer health [2]. In this regard, organic manures have several advantages like they supply plant nutrients, including micronutrients, and improve soil biological properties. Organic nutrient sources (FYM and vermicompost) can be utilized as plant growth media and soil conditioner which supply plant nutrients slowly but steadily throughout the plant growth period [3,4]. In addition to that, the bioinoculants improve plant available nutrients in the rhizosphere and also release plant growth promoting substances [5]. Some promising results were observed regarding the improvement of quality in medicinal and aromatic plants through organic nutrient managements [6]. Considering the economic importance of ashwagandha in national and international markets and possible environmental benefits, organic nutrient management is the need of the hour. Keeping this view in consideration an experiment entitled "Effect of different organic sources of nutrients on quality and economics of ashwagandha [*Withania somnifera* (L.) Dunal].

2. MATERIALS AND METHODS

A field experiment was conducted at College Farm, College of Horticulture, Sardarkrushinagar Dantiwada Agricultural University, Jagudan. Dist. Mehsana, Gujarat during *kharif* season of the year 2021-2022. Geographically, this location is situated at 23°53'N latitude and 72°43'E longitude at an elevation of 90.6 meters above mean sea level. It is situated in the North Gujarat Agro-climatic Zone IV of the Gujarat state.

The experiment entitled, Effect of different organic sources of nutrients on quality and economics of ashwagandha [*Withania somnifera* (L.) Dunal] was carried out during *Kharif* 2021-22 at College Farm, College of Horticulture, Sardarkrushinagar Dantiwada Agricultural University, Jagudan, Dist. Mehsana, Gujarat. Experiment was laid out in randomized block

design with three replications and twenty treatments *viz*., T_1: 100% RDN through FYM; T_2: 100% RDN through Vermicompost; T_3: 100% RDN through Neem cake; T_4: 100% RDN through Poultry manure; T_5: 80% RDN through FYM; T_6: 80% RDN through Vermicompost; T_7: 80% RDN through Neem cake; T_8: 80% RDN through Poultry manure; T_9: 60% RDN through FYM; T_{10}: 60% RDN through Vermicompost; T_{11}: 60% RDN through Neem cake; T_{12}: 60% RDN through Poultry manure; T_{13}: 80% RDN through FYM + *Azotobacter* + KSM + PSB; T_{14}: 80% RDN through Vermicompost + *Azotobacter* + KSM + PSB; T_{15}: 80% RDN through Neem cake+ *Azotobacter* + KSM + PSB; T_{16}: 80% RDN through Poultry manure + *Azotobacter* + KSM + PSB; T_{17}: 60% RDN through FYM + *Azotobacter* + KSM + PSB; T_{18}: 60% RDN through Vermicompost + *Azotobacter* + KSM + PSB; T_{19}: 60% RDN through Neem cake + *Azotobacter* + KSM + PSB; T_{20}: 60% RDN through Poultry manure + *Azotobacter* + KSM + PSB. Seeds of ashwagandha cv. Gujarat Anand Ashwagandha 1 was sown at a spacing of 30 cm × 15 cm followed by light irrigation was provided. The experimental plot was maintained through following cultural practices *viz.*, thinning, irrigation, weeding *etc.* The data recorded for various parameters during the course of investigation were statistically analyzed by a procedure appropriate to the design of experiment as described by Panse and Sukhatme [7]. The significance of difference was tested by "F" test at 5 per cent level.

For qualitative parameters studies during the crop growth period, ten plants were selected randomly from net plot and tagged in each plot for recording quality parameters *viz*., chlorophyll a, b and total (mg/g), and withanolides (%).

Well prepared vermicompost was brought from Livestock Research Station, S. D. Agricultural University, Sardarkrushinagar. The FYM, poultry manure and neem cake were procured from the local market. The farm yard manure (FYM), vermicompost, neem cake and poultry manure used in present experiment were analyzed for N, P and K content (%) by using standard methods [8] before application in field which was given in Table 1. Application of RDN through different organic sources of nutrients was given as per treatments.

Various biofertilizers *viz*., *Azotobacter*, potassium solubilizing microorganisms (KSM) and phosphate solubilizing bacteria (PSB) were used in present study which were procured from Department of Agricultural Microbiology, Anand Agricultural University, Anand. *Azotobacter*, potassium solubilizing microorganisms (KSM) and phosphate solubilizing bacteria (PSB) each @ 2.5 litre/ha were mixed thoroughly with different organic manures as per treatments before its application.

The gross realization [9] in term of rupees per hectare was worked out by considering the prevailing market price of the ashwagandha under each treatment during the experiment. The cost of cultivation was worked out by considering the expenses incurred for cultural operations from preparation tillage to harvesting including the cost of inputs *viz*., seeds, organic manures, biofertilizers, irrigation, labour wages *etc.* under each treatment. The cost of cultivation was deducted from the gross realization to work out the net profit under each treatment. The benefit cost ratio (BCR) was calculated on the basis of the formula given below:

$$\text{BCR (\%)} = \frac{\text{Gross realization (₹/ha)}}{\text{Total cost of cultivation(₹/ha)}}$$

Table 1. N, P and K content (%) of different organic manures

Sr. No.	Organic manures	N (%)	P_2O_5 (%)	K_2O (%)
1	FYM	0.52	0.26	0.52
2	Vermicompost	1.18	0.44	0.60
3	Neem cake	5.17	1.10	1.48
4	Poultry manure	2.99	2.65	2.10

3. RESULTS AND DISCUSSION

3.1 Effect of Different Organic Sources of Nutrients on Chlorophyll a, b and Total (mg/g)

The data pertaining to chlorophyll a, b and total (mg/g) as influenced by different sources of organic manures are presented in Table 2. Significantly maximum chlorophyll a (1.92 mg/g), chlorophyll b (0.75 mg/g) and total chlorophyll content (2.11 mg/g) were found with treatment T_{16} (80% RDN through Poultry manure + *Azotobacter* + KSM + PSB) at 90 DAS (at full bloom stage) which was at par with T_{15} and T_{20} treatments. Whereas, minimum chlorophyll a (1.29 mg/g), chlorophyll b (0.19 mg/g) and total chlorophyll content (1.38 mg/g) were obtained with treatment T_9 (60% RDN through FYM) at 90 DAS (at full bloom stage).

Maximum chlorophyll content in leaves of ashwagandha might be due to increased nutrient content, rapid mineralization, optimum C/N ratio and more availability of nitrogen supplied by poultry manure along with biofertilizers, leading to better vegetative growth and yield [10]. These results are in accordance with the findings of Deshpande et al. [11] and Onwu et al. [12] in okra.

3.2 Effect of Different Organic Sources of Nutrients on Withanolides (%)

The data presented in Table 3 showed that significantly maximum withanolides content (0.32%) was observed with treatment T_{16} (80 % RDN through Poultry manure + *Azotobacter* + KSM + PSB) which was at par with T_{15} and T_{20} treatments. Whereas, minimum withanolides content (0.21%) was recorded with treatment T_9 (60% RDN through FYM). It might be due to alkaloids being the products of nitrogen metabolism, the production of alkaloids is directly related to nitrogen supply to the plants. Thus, maximum availability of nitrogen through poultry manure and biofertilizers might have played an important role in biosynthesis and accumulation of alkaloid [13]. This result is supported by Vijayabharati [14] in ashwagandha.

Table 2. Effect of different organic sources of nutrients on chlorophyll a, b and total at 90 DAS (at full bloom stage) (mg/g)

Tr. No.	Treatments detail	Chlorophyll (mg/g)		
		A	b	total
T_1	100% RDN through FYM	1.49	0.39	1.67
T_2	100% RDN through Vermicompost	1.36	0.26	1.55
T_3	100% RDN through Neem cake	1.34	0.25	1.53
T_4	100% RDN through Poultry manure	1.52	0.43	1.71
T_5	80% RDN through FYM	1.50	0.42	1.69
T_6	80% RDN through Vermicompost	1.39	0.29	1.57
T_7	80% RDN through Neem cake	1.52	0.41	1.70
T_8	80% RDN through Poultry manure	1.31	0.20	1.42
T_9	60% RDN through FYM	1.29	0.19	1.38
T_{10}	60% RDN through Vermicompost	1.32	0.23	1.45
T_{11}	60% RDN through Neem cake	1.49	0.39	1.68
T_{12}	60% RDN through Poultry manure	1.36	0.26	1.54
T_{13}	80% RDN through FYM + *Azotobacter* + KSM + PSB	1.54	0.43	1.72
T_{14}	80% RDN through Vermicompost + *Azotobacter* + KSM + PSB	1.57	0.42	1.75
T_{15}	80% RDN through Neem cake + *Azotobacter* + KSM + PSB	1.83	0.73	2.02
T_{16}	80% RDN through Poultry manure + *Azotobacter* + KSM + PSB	1.92	0.75	2.11
T_{17}	60% RDN through FYM + *Azotobacter* + KSM + PSB	1.43	0.32	1.61
T_{18}	60% RDN through Vermicompost + *Azotobacter* + KSM + PSB	1.38	0.27	1.56
T_{19}	60% RDN through Neem cake + *Azotobacter* + KSM + PSB	1.56	0.46	1.75
T_{20}	60% RDN through Poultry manure + *Azotobacter* + KSM + PSB	1.82	0.72	2.00
S.Em. ±		0.04	0.01	0.05
CD at 5%		0.11	0.03	0.14

Table 3. Effect of different organic sources of nutrients on withanolides (%)

Tr. No.	Treatments detail	Withanolides (%)
T_1	100% RDN through FYM	0.24
T_2	100% RDN through Vermicompost	0.26
T_3	100% RDN through Neem cake	0.25
T_4	100% RDN through Poultry manure	0.26
T_5	80% RDN through FYM	0.24
T_6	80% RDN through Vermicompost	0.23
T_7	80% RDN through Neem cake	0.25
T_8	80% RDN through Poultry manure	0.22
T_9	60% RDN through FYM	0.21
T_{10}	60% RDN through Vermicompost	0.23
T_{11}	60% RDN through Neem cake	0.24
T_{12}	60% RDN through Poultry manure	0.26
T_{13}	80% RDN through FYM + *Azotobacter* + KSM + PSB	0.23
T_{14}	80% RDN through Vermicompost + *Azotobacter* + KSM + PSB	0.26
T_{15}	80% RDN through Neem cake + *Azotobacter* + KSM + PSB	0.30
T_{16}	80% RDN through Poultry manure + *Azotobacter* + KSM + PSB	0.32
T_{17}	60% RDN through FYM + *Azotobacter* + KSM + PSB	0.26
T_{18}	60% RDN through Vermicompost + *Azotobacter* + KSM + PSB	0.25
T_{19}	60% RDN through Neem cake + *Azotobacter* + KSM + PSB	0.25
T_{20}	60% RDN through Poultry manure + *Azotobacter* + KSM + PSB	0.30
S.Em. ±		0.01
CD at 5%		0.02

Table 4. Effect of different organic sources of nutrients on economics

Treatment	Dry root yield per hectare (kg)	Seed yield per hectare (kg)	Gross realization (₹/ha)	Total cost of cultivation (₹/ha)	Net returns (₹/ha)	Benefit: Cost Ratio (BCR)
1	**2**	**3**	**4 ($2 \times 250 +$ 3 x 300)**	**5**	**6 (4-5)**	**7 (4/5)**
T_1	395.17	114.39	133110	55125	77985	2.41
T_2	412.74	130.56	142353	59867	82486	2.38
T_3	385.15	111.96	129876	59058	70817	2.20
T_4	386.61	118.97	132344	54748	77595	2.42
T_5	391.02	123.8	134895	54548	80347	2.47
T_6	414.79	129.29	142485	58342	84143	2.44
T_7	464.45	139.88	158077	57695	100382	2.74
T_8	370.31	108.32	125074	54247	70827	2.31
T_9	346.70	99.33	116474	53971	62503	2.16
T_{10}	441.22	134.01	150508	56816	93692	2.65
T_{11}	369.87	117.44	127700	56331	71369	2.27
T_{12}	430.46	137.62	148901	53745	95156	2.77
T_{13}	378.24	116.32	129456	55448	74008	2.33
T_{14}	546.85	171.67	188214	59242	128972	3.18
T_{15}	472.41	136.62	159089	58595	100494	2.72
T_{16}	558.96	180.38	193854	55147	138707	3.52
T_{17}	383.52	114.04	130092	54871	75221	2.37
T_{18}	470.00	141.51	159953	57716	102237	2.77
T_{19}	437.54	134.32	149681	57231	92450	2.62
T_{20}	519.22	166.67	179806	54645	125161	3.29

3.3 Effect of Different Organic Sources of Nutrients on Economics

Influence of different organic sources of nutrients on net returns and benefit: cost ratio in ashwagandha are presented in Table 4.

Gross realization was multiplying the dry root and seed yield per hectare with the selling price of ashwagandha parts (₹ 250.00 per kg dry root and ₹ 300.00 per kg seed). Maximum net return (₹ 1,38,707/ha) and BCR (3.52) was found under treatment T_{16} (80% RDN through Poultry manure + *Azotobacter* + KSM + PSB). Whereas, the minimum net return (₹ 62,503/ha) and BCR (2.16) was found under treatment T_9 (60% RDN through FYM).

Maximum net return and BCR could be attributed to production of high yield of dry roots and seed by application of 80% RDN through Poultry manure + *Azotobacter* + KSM + PSB with comparatively moderate cost of cultivation. This result is supported by application of poultry manure @ 5 tone/hectare + biofertilizers who reported by Ramadugu [15] in ashwagandha.

4. CONCLUSION

It can be concluded that the application of different organic sources of nutrients significantly influenced quality and economics. However, application of 80% RDN through poultry manure + *Azotobacter* + KSM + PSB (T_{16}) was found beneficial for obtaining higher yield of better quality and economic returns in ashwagandha.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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