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Kudichetty Sai Teja
M.Sc., Department of Plantation, Spices, Medicinal and Aromatic Crops, College of Horticulture, Dr. YSR Horticultural University, Anantharajupeta, Andhra Pradesh, India

G Thanuja Sivaram
Associate Professor, Department of Plantation, Spices, Medicinal and Aromatic Crops, College of Horticulture, Dr. YSR Horticultural University, Anantharajupeta, Andhra Pradesh, India

KM Yuvaraj
Professor and Head, Department of Plantation, Spices, Medicinal and Aromatic Crops, College of Horticulture, Dr. YSR Horticultural University, Anantharajupeta, Andhra Pradesh, India

Lalitha Kadiri
Assistant Professor, Department of Agronomy and Soil Science, College of Horticulture, Dr. YSR Horticultural University, Anantharajupeta, Andhra Pradesh, India

M Paratpara Rao
Associate Professor, Department of Genetics and Plant Breeding, College of Horticulture, Dr. YSR Horticultural University, Venkataramannagudem, Andhra Pradesh, India

Corresponding Author:
Kudichetty Sai Teja
M.Sc., Department of Plantation, Spices, Medicinal and Aromatic Crops, College of Horticulture, Dr. YSR Horticultural University, Anantharajupeta, Andhra Pradesh, India

Effect of different dates of sowing, organic manures on protein, fiber and alkaloid content in leaves and roots of ashwagandha (*Withania somnifera*)

Kudichetty Sai Teja, G Thanuja Sivaram, KM Yuvaraj, Lalitha Kadiri and M Paratpara Rao

Abstract
An experiment was conducted at Dept. of PSMA Block, College of Horticulture, Dr. YSR Horticultural University, Anantharajupeta, to know the protein, fiber, alkaloid content in both leaves and roots of Ashwagandha. The experiment was laid out in Split Plot Design with a total of 16 treatments replicated thrice with four sowing dates (First fortnight of September, second fortnight of September, first fortnight of October and Second fortnight of October), three Organic manures (FYM, Vermicompost, Neem Cake) and NPK (40:60:20 kg ha^{-1}). Results reveled that maximum protein, fiber, alkaloid content was recorded with September 15th sown crop when compared to other dates sown crop, when as organic manures shown all significant result in compared with RDF.

Keywords: *Withania somnifera*, ashwagandha, Anantharajupeta, protein, fiber, alkaloid content

Introduction
Ashwagandha (*Withania somnifera* Dunal.) known as Indian Ginseng belongs to the family Solanaceae is an important cultivated medicinal crop of India and has been mentioned as an important drug in ancient Ayurvedic literature. The roots of this plant contain many alkaloids, such as Withanine, Somniferine (Dastur *et al*., 1970) [5] the total alkaloids of the root have been reported to vary between 0.13 to 0.31 (Anon *et al*., 1976) [19]. Whereas leaves are also having protein and alkaloid content. The research works related to the role of different dates of sowing with different organic manures on Ashwagandha is scanty. However the present investigation was undertaken to study the effect of different dates of sowing, Organic Manures on Protein, Fiber and Alkaloid content in Leaves and Roots of ashwagandha (*Withania somnifera*)**.** Starch and Fiber contents of ashwagandha root play a dominant role in determining root quality. Brittle roots having high starch and low Fiber are highly priced because of their ease in making powder and are quoted to be characteristic root textural features of commercial ashwagandha (Asthana *et al.*, 1989 an Patidar *et al.*, 1990) [1, 14]. Organic cultivation technology is the best solution to produce quality medicinal herb. Further, organic nutrient sources (FYM, compost and bio fertilizers) have a beneficial impact on soil properties and produce safe plants with high-quality bioactive compound.

Materials and Methods
The experiment was carried out during September 2020 to March 2020 in College of Horticulture, Anantharajupeta. The experiment was laid out with four main plots (First fortnight of September, second fortnight of September, first fortnight of October and Second fortnight of October), and four sub plots, (three Organic manures (FYM, Vermicompost, Neem Cake) and NPK (40:60:20 kg ha^{-1}), in Split Plot Design with a total of 16 treatments with replicated thrice. The experimental area was divided into plots of 1.5m x 1.5m size. Irrigation channels of 0.75 m size were provided. The seeds mixed with sand at the ratio of 1:1 and sown directly in the field by line sowing method. The data recorded on protein, fiber, alkaloid content in both leaves and roots were subjected to statistical analysis.

Results and Discussion
Effect of different dates of sowing and organic manures on protein, fiber, Alkaloid content in leaves and roots of Ashwagandha
Protein content (%): The different dates of sowing had non-significant influence on protein

content (Table 1). Among different dates of sowing, highest protein content (6.28%) in roots was recorded with the M_1 (First fortnight of September) which was at par with M_2 (second fortnight of September) (5.56%) in roots, the minimum value was recorded in M_4 (second fortnight of October) (5.36%) in roots. The same trend was observed in leaves, protein content (5.16%) was recorded with the M_1 (First fortnight of September) which was at par with M_2 (second fortnight of September) (4.80%) and the minimum value was recorded in M_4 (second fortnight of October) (4.17%) in leaves.

The different organic sources of nutrient were influenced non-significantly on protein content. Among the different organic sources of nutrient, highest protein content (5.99%) in roots was recorded with application of S_1 (100% RDN through FYM) which is on par with S_2 (100% RDN through vermicompost) (5.81%) and the minimum value (5.30%) in roots was recorded in S_3 (100% RDN through Neem cake) (5.34%). In leaves highest protein content (4.88%) was recorded with application of S_1 (100% RDN through FYM) which is on par with S_2 (100% RDN through vermicompost) (4.77%) and minimum value was recorded in S_3 (100% RDN through Neem cake) (4.37%).

The interaction effect between dates of sowing and organic sources of nutrient was non-significant in main plots and significant in case of subplots. The September sowing was obtained statistically superior over October sowing. The protein content in ashwagandha was increased with increased level of FYM might be due to better soil physical, chemical and biological properties. The results are similar findings by Shah and Hasan (1999) [20] who reported that crude protein content enhanced by increased levels of nitrogen in oat. Also reported that application of 80 kg N increased protein content in fodder oat.

Table 1: Protein content in roots and leaves of ashwagandha

	Protein% in Roots					Protein% in leaves				
	S_1	**S_2**	**S_3**	**S_4**	**Mean**	**S_1**	**S_2**	**S_3**	**S_4**	**Mean**
M_1	6.87	6.92	6.03	5.27	6.28	5.23	5.65	4.98	4.79	5.16
M_2	5.56	5.78	5.41	5.49	5.56	5.17	4.59	4.68	4.76	4.80
M_3	5.38	5.62	5.06	5.48	5.39	4.57	4.79	4.06	4.01	4.36
M_4	5.42	5.61	4.85	5.54	5.36	4.12	4.48	3.74	4.36	4.17
Mean	5.81	5.99	5.34	5.45		4.77	4.88	4.37	4.48	
Factors	CD		S.E(m)			CD		S.E(m)		
M	NS		0.200			NS		0.232		
S	0.50		0.172			0.39		0.137		
S at M	NS		0.344			NS		0.274		
M at S	NS		0.507			NS		0.469		

Fiber content%

The different dates of sowing had significant influence on fiber content (Table 2). Among different dates of sowing, lowest fiber content (17.47%) in roots and was recorded with the M_1 (first fortnight of September) which was at par with M_2 (second fortnight of September) (18.51%) in roots. And the maximum fiber content was recorded in M_4 (second fortnight of October) (21.09%) in roots. Whereas in case of leaves different dates of sowing had non-significant influence on fiber content minimum fiber content (0.63%) was observed in M_1 (first fortnight of September which) was at par with M_2 (second fortnight of September) (0.67%) the maximum fiber content was recorded in M_4 (second fortnight of October) (0.71%) in leaves.

The different organic sources of nutrient were influenced significantly on fiber content. Among the different organic sources of nutrient, lowest fiber content (16.82%) in roots was recorded with application of S_2 (100% RDN through vermicompost) which was on par with S_1 (100% RDN through FYM) (18.38%) and the maximum value (21.33%) in roots was recorded in S_3 (100% RDN through Neem cake). whereas in case of leaves the lowest fiber content (0.54%) in leaves was recorded with application of S_2 (100% RDN through vermicompost) which is on par with S_1 (100% RDN through FYM) (0.57%) and the maximum value (0.89%) in leaves was recorded in S_3 (100% RDN through Neem cake).

The interaction effect between dates of sowing and organic sources of nutrient was significant in roots. Among the interactions M_1S_2 showing (14.14%) lowest fiber content and the highest was recorded in M_4S_3 (23.82%). Whereas in case of interaction effect in leaves it was found to be non-significant. The fiber content in ashwagandha was decreased with increased level of FYM might be due to better soil physical, chemical and biological properties. The results are similar findings by Shah and Hasan (1999) [20] who reported that crude protein content enhanced by increased levels of nitrogen in oat.

Table 2: Fiber content in both roots and leaves of ashwagandha

	Fiber content in roots (%)					Fiber content in leaves (%)				
	S_1	**S_2**	**S_3**	**S_4**	**Mean**	**S_1**	**S_2**	**S_3**	**S_4**	**Mean**
M_1	15.14	14.14	21.19	19.41	17.47	0.54	0.46	0.87	0.64	0.63
M_2	20.03	16.56	19.56	17.90	18.51	0.57	0.56	0.87	0.70	0.67
M_3	20.36	17.25	20.75	19.65	19.50	0.59	0.57	0.90	0.72	0.69
M_4	17.97	19.32	23.82	23.22	21.09	0.60	0.59	0.91	0.74	0.71
Mean	18.38	16.82	21.33	20.05		0.57	0.54	0.89	0.70	
Factors	CD		S.E(m)			CD		S.E(m)		
M	1.02		0.295			NS		0.017		
S	1.44		0.496			0.03		0.006		
S at M	2.89		0.992			NS		0.013		
M at S	3.82		1.285			NS		0.029		

Alkaloid content%

The different dates of sowing had significant influence on alkaloid content (Table 3). Among different dates of sowing, highest alkaloid content (0.49%) recorded with the M_1 (first fortnight of September) which is on par with M_2 (second fortnight of September) (0.47%) and the minimum value was recorded in M_4 (second fortnight of October) (0.39%) in roots. Whereas in case of leaves maximum alkaloid content (0.26%) was noticed in M_1 (first fortnight of September) which was on par with M_2 (second fortnight of September) (0.23%) and M_3 (first fortnight of October) (0.22%) and the lowest value was M_4 (second fortnight of October) (0.21%).

The different organic sources of nutrient were influenced significantly on alkaloid content. Among the different organic sources of nutrient, highest alkaloid content (0.49%) in roots was recorded with application of S_2 (100% RDN through vermicompost) which was on par with S_1 (100% RDN through FYM) (0.46%) and the minimum value (0.41%) in roots was recorded in S_3 (100% RDN through Neem cake). In leaves maximum alkaloid content (0.27%) was noticed in S2 (100% RDN through vermicompost) which was on par with S_1 (100% RDN through FYM) (0.23%) and the minimum value (0.21%) in roots was recorded in S_3 (100% RDN through Neem cake).

The interaction effect between dates of sowing and organic

sources of nutrient was significant. Among the interactions M_1S_2 showing (0.55%) highest alkaloid content and the lowest was recorded in M_4S_3 (0.34%). Whereas in leaves among the interactions M_1S_2 showing (0.31%) and lowest fiber content and the highest was recorded in M4S3 (0.16%). These results are in line with the findings of Rashmi (2013) [16] in ashwagandha, Somnath *et al*. (2005) [17] in *Plectrathus forskohlii*, Sanjutha *et al*. (2008) [18] in Kalmegh.

Table 3: Alkaloid content in both roots and leaves of ashwagandha

	Total alkaloid content in roots (%)					Total alkaloid content in leaves (%)				
	S_1	**S_2**	**S_3**	**S_4**	**Mean**	**S_1**	**S_2**	**S_3**	**S_4**	**Mean**
M_1	0.52	0.55	0.44	0.46	0.49	0.26	0.31	0.22	0.25	0.26
M_2	0.42	0.51	0.45	0.48	0.47	0.20	0.25	0.23	0.24	0.23
M_3	0.44	0.50	0.41	0.43	0.44	0.17	0.30	0.21	0.21	0.22
M_4	0.44	0.41	0.34	0.36	0.39	0.29	0.21	0.16	0.17	0.21
Mean	0.46	0.49	0.41	0.43		0.23	0.27	0.21	0.22	
Factors	CD		S.E(m)			CD		S.E(m)		
M	0.04		0.013			0.03		0.010		
S	0.03		0.010			0.04		0.014		
S at M	0.06		0.021			0.08		0.028		
M at S	0.09		0.031			0.11		0.037		

Conclusion

The results showed that sowing of ashwagandha in the month of September have maximum protein and alkaloid content whereas minimum values was recorded in fiber content when compared to sowing in the month of October and can be concluded that organic manures will have more impact on increase the protein and alkaloid content and decrease in fiber content when compare to recommend dose of fertilizers.

Future scope

- The experiment should be carried out for further one or two years to draw concrete conclusion for the recommendation for organically grown ashwagandha.
- Further research should focus to find out the effective combination of organic manures along with inter cropping in different horticultural crops.
- The effect of integrated nutrient and water management practices needs to be studied under for sole and intercropping system of ashwagandha.
- Research needs to be conducted on value added products of ashwagandha.

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