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Effect of various methods of sowing on growth parameters and biochemical traits of Ashwagandha (*Withania somnifera* (L.) Dunal)

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Abstract
The present investigation entitled "Effect of various methods of sowing on growth parameters and biochemical traits of Ashwagandha. (*Withania somnifera* (L.) Dunal)." was carried out at Research Cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur, during *rabi* season of 2017-2018. The experiment was laid out in split plot design with three replications. The whole treatments were divided into main plot i.e. flat bed, ridge and furrow method and sub plot i.e. control, FYM @ 10 t ha^{-1}, FYM @ 15 t ha$^{-1,}$ Vermicompost @ 5 t ha^{-1}, Vermicompost @ 7.5 t ha^{-1}, Castor cake @ 1.5 t ha^{-1}, Castor cake @ 2.5 t ha^{-1}, RDF(NPK @ 40:60:20 kg ha^{-1}). Ashwagandha variety GAA-1 was sown on 30th October 2017 and harvested on 05th June 2018. Observations regarding growth parameters and bio-chemical traits of ashwagandha plant. based on different sowing methods, maximum plant height (cm), number of leaves plant^{-1}, number of primary branches plant^{-1}, number of secondary branches plant^{-1}, chlorophyll content (SPAD) value and protein content were recorded maximum with ridge and furrow sowing method as compared to flatbed sowing method while based on application of organic source of nutrients, maximum plant height (cm), number of leaves plant^{-1}, number of primary branches plant^{-1}, number of secondary branches plant^{-1}, chlorophyll content (SPAD) value and protein content were recorded with application of FYM @ 15 t ha^{-1} as compared to other organic source of nutrient and their levels for ashwagandha crop. Ridge and furrow sowing method with FYM @ 15 t ha^{-1} gave best results in terms of all growth parameters and biochemical traits of ashwagandha.

Keywords: Vermicompost, flat bed, sub plot, castor cake, RDF

Introduction
Ashwagandha is 3rdimportant prioritized medicinal plant listed by National Medicinal Plant Board (NMPB) and also known as Indian Ginseng. Ashwagandha (*Withania somnifera*) belongs to family *Solanaceae* and it attains a height of about 170cm. The fruits or berries are smooth, spherical, red coloured with 6 mm diameter enclosed in an inflated and membranous calyx. (Nigam and kandalkar 1995) [3]. It is widely distributed in the tropical climate of Indian sub-continent, South Africa, the Mediterranean and Middle East regions. The average rainfall of this state is 1200-1400 mm annually and mostly cropping system depends on rainfall. Chhattisgarh Government has declared the state as Herbal State due to extremely rich and unique biodiversity for medicinal plants however use of chemicals hampers soil health. Organic manures improve the physical properties of soils, which is very beneficial for plants. Looking at the ill effects of such chemicals, it was considered of interest to use organic manures like farmyard manure and vermicompost. These both manures are very beneficial for proper growth and crop production of ashwagandha plant. Organic manures are considered for producing good yielding produce by improving water penetration, capacity of water holding, soil structure improvement, microbial biomass, nutrient availability and resistance to drought and heat stress. The nutrient management in ashwagandha may be one of the major strategies for increasing of the yield of ashwagandha.

Materials and Methods
Description of materials used and methods adopted during the course of investigation in order to conduct the experiment and record scheduled observations, the present investigation entitled Effect of various methods of sowing on growth parameters and bio-chemical traits of

Ashwagandha. (*Withania somnifera* (L.) Dunal).” was carried out at Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G) during the Rabi 2017-18. The experiment was conducted at Herbal Garden Research cum Instructional farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh) in mid eastern part of Chhattisgarh in the latitude at 21.16^0 North and 81.36^0 East of 289 meters above mean sea level having sub tropical humid climate season. The whole treatments were divided into main plot i.e. flat bed, ridge and furrow method and sub plot i.e. control, FYM @ 10 t ha^{-1}, FYM @ 15 t ha^{-1}, Vermicompost @ 5 t ha^{-1}, Vermicompost @ 7.5 t ha^{-}, Castor cake @ 1.5 t ha^{-1}, Castor cake @ 2.5 t ha^{-1}, RDF(NPK @ 40:60:20 kg ha^{-1}). The experiment was laid out in split plot design with three replications. The maximum temperature recorded was 42.9°C during the period from 07th May to 13th May 2018 and minimum 9.5°C in during 24th December to 31th December 2017. The maximum relative humidity recorded was 90% during 05th November to 11th November 2017 and minimum 15% during 26th March to 1st April 2018. The observations on growth parameters and bio-chemical traits like plant height, number of leaves, number of primary branches, number of secondary branches, chlorophyll content (SPAD) value and protein content were recorded at different time intervals. Five plants were selected and tagged for each accession for taking observations and mean data were used for statistical analysis.

Results and Discussion

Plant height (cm)

The results revealed that the plant height of Ashwagandha recorded at 30, 60, 90, 120 DAS and at harvest. The plant height was significantly influenced by sowing methods except at 30 DAS. The tallest plant height (80.80 cm) was recorded with ridge and furrow sowing method at harvest and the shortest plant (78.48 cm) was recorded with flat bed sowing method at the same DAS. Ashwagandha sown on ridge and furrow resulted in significantly taller plant at all growth stages except 30 DAS which might be due to better soil physical conditions, suitable aeration, increased nutrient uptake, less leaching losses and lack of water stagnation led to higher crop growth rate under ridge and furrow method in comparison to flat bed method.

Table 1: Plant height (cm) of ashwagandha as influenced by sowing methods and organic sources of nutrients

Treatment	Plant height (cm)				
	30 DAS	60 DAS	90 DAS	120 DAS	At harvest
Main plot: Sowing methods (MS)					
M1: Flat bed method	3.60	33.57	56.83	71.01	78.48
M2: Ridge and furrow method	3.70	36.77	63.04	74.83	80.80
S.Em±	0.11	0.14	0.44	0.09	0.18
CD (P= 0.05%)	NS	0.85	2.69	0.55	1.07
Sub plot: Organic sources of nutrient (S)					
S1: Control	3.67	31.60	44.84	58.68	70.67
S2: FYM @ 10 t ha^{-1}	3.79	40.33	65.50	80.80	84.28
S3: FYM @ 15 t ha^{-1}	3.80	43.58	67.74	82.24	86.01
S4: Vermicompost @ 5 t ha^{-1}	3.57	33.46	60.31	73.17	79.53
S5: Vermicompost @ 7.5 t ha^{-1}	3.70	36.50	64.82	78.67	82.83
S6: Castor cake 1.5 t ha^{-1}	3.50	29.50	55.04	64.51	75.54
S7: Castor cake 2.5 t ha^{-1}	3.55	32.93	58.78	68.31	77.78
S8: RDF	3.60	33.47	62.86	74.99	80.51
SEm±	0.18	0.72	0.61	0.62	0.73
CD (P= 0.05%)	NS	2.09	1.77	1.79	2.12
Interaction (MS× S)	NS	S	S	S	S

The plant height was significantly influenced by different organic sources of nutrient except at 30 DAS. The maximum plant height (86.01 cm) was observed with FYM @ 15 t ha^{-1} at harvest followed by application of FYM @ 10 t ha^{-1} (84.28 cm) at the same DAS. Interaction effects between sowing methods and organic sources of nutrient for plant height were found significant. Guleria *et al.* (2013) [1] reported that plant grown in vermicompost and farm yard manure pre-treated soil exhibited maximum increase in all morphological parameters of ashwagandha.

Number of leaves plant^{-1}

The number of leaves plant^{-1} in ashwagandha was recorded at 30, 60, 90, 120 DAS and at harvest stage. Among these observations significant increase in number of leaves plant^{-1} was observed the maximum number of leaves plant^{-1} (170.69) showed at 120 DAS applicable with ridge and furrow sowing method and lowest numbers were recorded with flatbed sowing method (169.47) at the same DAS.

The different organic sources of nutrients also showed significant number of leaves plant^{-1} in ashwagandha at all stages of observations. The number of leaves plant^{-1} was found superior with the application of FYM @ 15 t ha^{-1} (185.69) at 120 DAS followed by application of FYM @ 10 t ha^{-1} (178.14) at the same DAS. The interaction effect between sowing methods and organic sources of nutrient for number of leaves were also found significant. Number of leaves plant^{-1} was influenced significantly due to different sowing methods and organic sources of nutrient at all growth stages. Joy *et al.* (2005) [2] reported that the maximum number of leaves in black musli with the application of FYM 30 t ha^{-1}.

Table 2: No. of leaves plant^{-1} of ashwagandha as influenced by sowing methods and organic sources of nutrients

Treatment	No. of leaves plant^{-1}				
	30 DAS	60 DAS	90 DAS	120 DAS	At harvest
Main plot: Sowing methods (MS)					
M1: Flat bed method	6.32	52.61	151.46	169.47	164.26
M2: Ridge and furrow method	7.06	55.41	153.93	170.69	166.63

S.Em±	0.10	0.49	1.18	0.25	0.25
CD (P= 0.05%)	0.64	2.97	7.18	1.53	1.53
Sub plot: Organic sources of nutrient (S)					
S1: Control	5.76	43.44	129.82	158.49	145.35
S2: FYM @ 10 t ha^{-1}	7.37	58.71	163.02	178.14	175.88
S3: FYM @ 15 t ha^{-1}	7.71	60.08	165.75	185.69	178.72
S4: Vermicompost @ 5 t ha^{-1}	6.51	53.31	152.17	167.51	164.93
S5: Vermicompost @ 7.5 t ha^{-1}	6.71	58.94	157.46	171.55	168.80
S6: Castor cake 1.5 t ha^{-1}	6.45	50.90	148.77	161.91	160.41
S7: Castor cake 2.5 t ha^{-1}	6.48	52.39	150.81	165.11	163.70
S8: RDF	6.52	54.33	153.77	168.25	165.75
SEm±	0.29	1.49	2.86	2.03	1.77
CD (P= 0.05%)	0.84	4.32	8.28	5.87	5.13
Interaction (MS× S)	S	S	S	S	S

Number of primary branches plant^{-1}

The different sowing methods were influenced significantly on number of primary branches plant^{-1} at all growth stages. The number of primary branches in ashwagandha was recorded at 90, 120 DAS and at harvest and their results are presented in (Table 3). The highest number of primary branches (8.65) was recorded at harvest stage under ridge and furrow sowing method whereas, lowest number of primary branches (7.87) with flat bed sowing method at the same DAS. Nitrogen supply through FYM and vermicompost which increase vegetative growth of ashwagandha.

Table 3: No. of primary branches plant^{-1} of ashwagandha as influenced by sowing methods and organic sources of nutrients

Treatment	No. of primary branches plant^{-1}		
	90 DAS	120 DAS	At harvest
Main plot: Sowing methods (MS)			
M1: Flat bed method	3.08	5.63	7.87
M2: Ridge and furrow method	3.41	6.61	8.65
S.Em±	0.09	0.19	0.09
CD (P= 0.05%)	0.57	1.13	0.52
Sub plot: Organic sources of nutrient (S)			
S1: Control	2.13	3.83	5.78
S2: FYM @ 10 t ha^{-1}	4.05	7.10	9.33
S3: FYM @ 15 t ha^{-1}	5.09	8.01	10.20
S4: Vermicompost @ 5 t ha^{-1}	3.10	5.67	8.65
S5: Vermicompost @ 7.5 t ha^{-1}	3.25	6.95	8.95
S6: Castor cake 1.5 t ha^{-1}	2.60	4.55	6.77
S7: Castor cake 2.5 t ha^{-1}	3.03	5.50	7.80
S8: RDF	3.15	5.75	8.84
SEm±	0.13	0.30	0.41
CD (P= 0.05%)	0.36	0.87	1.19
Interaction (MS× S)	S	S	S

The different organic sources of nutrient also showed significant number of primary branches in ashwagandha at all growth stages (90, 120 DAS and harvest) of observations. It increased considerably with an increase in age after sowing and the maximum number of primary branches (10.20) was recorded with the application of FYM @ 15 t ha^{-1} at harvest followed by application of FYM @ 10 t ha^{-1} (9.33) at the same DAS. The interaction effect between sowing methods and organic sources of nutrient were also found significant result. Guleria *et al*. (2013) [1] reported that the maximum branches were found under vermicompost in aloe vera.

Number of secondary branches plant^{-1}

The different sowing methods were showed significant increase of number of secondary branches plant^{-1} at all growth stages. The number of secondary branches in ashwagandha was recorded at 90, 120 DAS and at harvest stage and their results are presented in (Table 4). The highest number of secondary branches (12.57) was recorded at harvest under ridge and furrow sowing method whereas, found the lowest number of secondary branches with flat bed sowing method (11.91) at the same DAS. Nitrogen supply through FYM and vermicompost fetched good response which enhanced the vegetative growth of plant and get the ultimate higher number of secondary branches.

Table 4: No. of secondary branches plant^{-1} of ashwagandha as influenced by sowing methods and organic sources of nutrients

Treatment	No. of secondary branches plant-^{1}		
	90 DAS	120 DAS	At harvest
Main plot: Sowing methods (MS)			
M1: Flat bed method	5.15	9.38	11.91
M2: Ridge and furrow method	5.39	10.00	12.57
SEm±	0.03	0.06	0.01
CD (P= 0.05%)	0.19	0.39	0.03

Sub plot: Organic sources of nutrient (S)			
S1: Control	3.86	6.29	8.67
S2: FYM @ 10 t ha^{-1}	5.60	10.76	13.71
S3: FYM @ 15 t ha^{-1}	6.79	11.05	14.90
S4: Vermicompost @ 5 t ha^{-1}	5.31	9.72	12.40
S5: Vermicompost @ 7.5 t ha^{-1}	5.84	10.20	13.49
S6: Castor cake 1.5 t ha^{-1}	4.46	8.60	11.94
S7: Castor cake 2.5 t ha^{-1}	4.95	9.02	12.38
S8: RDF	5.33	9.90	12.44
S.Em±	0.13	0.19	0.17
CD (P= 0.05%)	0.39	0.56	0.49
Interaction (MS× S)	S	S	S

Organic sources of nutrient also showed significant number of secondary branches in ashwagandha. It increased considerably with an increase in age after sowing and the maximum number of secondary branches (14.90) was recorded with the application of FYM 15 t ha^{-1} at harvest followed by application of FYM @ 10 t ha^{-1} (13.71) at the same DAS. Kumar and Singh (2014) also found similar trends in rajma. However, Guleria *et al*. (2013) [1] reported that the maximum stem branches were found under vermicompost in aloe vera.

Chlorophyll content (SPAD) value

The chlorophyll content of plant was evaluated with the help of chlorophyll meter as a SPAD value. The data on SPAD value of ashwagandha at 30, 60, 90, 120 DAS and at harvest are presented in (Table 5). Significant differences were noticed in SPAD values due to all methods of sowing at different stages of observation. Among all plants observation highest value (73.04) was noticed from 90 to 120 DAS in ridge and furrow sowing method and lowest value (66.98) was recorded with flat bed sowing method.

Different organic sources of nutrients were also showed significant effect for SPAD value in ashwagandha at each 30 days interval till harvest stage. It increased considerably with an increase in age after sowing up to 90 DAS but it decreased thereafter. Maximum SPAD value was noticed at 120 DAS (77.05) with application of FYM @ 15 t ha^{-1} followed by application of FYM @ 10 t ha^{-1} (75.18) at the same DAS. The amount of nitrogen and phosphorus supply through FYM and vermicompost which increased vegetative growth and chlorophyll formation. Vermicompost serve as a reservoir of macro, secondary and micro nutrients, many hormones, antibiotics and organic matter content. The interaction effect between sowing methods and organic sources of nutrient were also found significant. Pandey *et al.* (2000) [4] and Rambo *et al.* (2010) [5] reported that increasing nutrient application also increase N content and chlorophyll content in corn. Hence, the value of relative chlorophyll content (SPAD) reflected N availability for ashwagandha.

Table 5: Chlorophyll content (SPAD) value of ashwagandha as influenced by sowing methods and organic sources of nutrients

Treatment	Chlorophyll content (SPAD) value				
	30 DAS	60 DAS	90 DAS	120 DAS	At harvest
Main plot: Sowing methods (MS)					
M1: Flat bed method	40.50	57.18	64.57	66.98	46.88
M2: Ridge and furrow method	41.50	57.94	66.89	73.04	48.54
SEm±	0.24	0.38	0.24	0.48	0.12
CD (P= 0.05%)	1.47	2.33	1.47	2.91	0.74
Sub plot: Organic sources of nutrient (S)					
S1: Control	35.43	48.67	58.99	57.06	38.14
S2: FYM @ 10 t ha^{-1}	43.74	60.18	68.74	75.18	50.08
S3: FYM @ 15 t ha^{-1}	44.21	61.18	70.02	77.05	52.12
S4: Vermicompost @ 5 t ha^{-1}	40.73	58.50	65.07	73.82	48.68
S5: Vermicompost @ 7.5 t ha^{-1}	42.92	59.46	68.34	75.54	49.46
S6: Castor cake 1.5 t ha^{-1}	39.67	56.40	63.46	62.50	46.06
S7: Castor cake 2.5 t ha^{-1}	40.17	57.41	64.07	64.23	47.34
S8: RDF	41.12	58.67	67.19	74.94	48.82
SEm±	0.83	0.58	0.86	0.82	0.43
CD (P= 0.05%)	2.42	1.69	2.48	2.38	1.26
Interaction (MS× S)	S	S	S	S	S

Protein percentage

The different sowing methods significantly influenced the protein content in ashwagandha (Table 6). Among different sowing methods, highest protein content (5.56%) was recorded with the ridge and furrow sowing method which was significantly superior over other methods of sowing.

The different organic sources of nutrient significantly influenced the protein content. Among the different organic sources of nutrient, highest protein content (6.18%) was recorded with application of FYM @ 15 t ha^{-1} which was found superior over other sources of nutrient and their levels.

Table 6: Protein (%) of ashwagandha as influenced by sowing methods and organic sources of nutrients

Treatment	Protein (%)
Main plot: Sowing methods (MS)	
M1: Flat bed method	5.12
M2: Ridge and furrow method	5.56
SEm±	0.06
CD (P= 0.05%)	0.34
Sub plot: Organic sources of nutrient (S)	
S1: Control	3.75
S2: FYM @ 10 t ha^{-1}	5.93
S3: FYM @ 15 t ha^{-1}	6.18
S4: Vermicompost @ 5 t ha^{-1}	5.68
S5: Vermicompost @ 7.5 t ha^{-1}	5.87
S6: Castor cake 1.5 t ha^{-1}	4.75
S7: Castor cake 2.5 t ha^{-1}	5.00
S8: RDF	5.75
S.Em±	0.21
CD (P= 0.05%)	0.61
Interaction (MS× S)	S

The interaction effect between sowing methods and organic sources of nutrient was significant. The Ridge and furrow sowing method was obtained statistically superior over flat bed sowing method. The protein content in ashwagandha was increased with increasing level of FYM may be due to better soil physical, chemical and biological properties. The results are similar findings by Shah and Hasan (1999) [6] who reported that protein content enhanced by increased levels of nitrogen in oat. Singh *et al*. (1996) [7] also reported that application of 80 kg N increased protein content in fodder oat.

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