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Growth parameters and seed yield of Ashwagandha (*Withania somnifera* (L.) Dunal) as influenced by sowing method and organic sources of nutrients

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Abstract
An experiment was conducted to find out the effect of different sowing methods and organic sources of nutrient on yield and quality of ashwagandha (*Withania somnifera* (L.) Dunal). The experiment was carried out during *rabi* seasion 2016-17 at college of agriculture, IGKV Raipur. Raipur is situated in 21^0 16' N latitude and 81^0 26' E longitudes. There were eighteen combinations of three sowing methods in main plot *i.e.* flat bed, ridge bed and raised bed and six sub plots *i.e.* control, FYM @ 10t ha^{-1}, FYM @15t ha^{-1}, vermicompost @ 5t ha^{-1}, vermicompost @ 7.5t ha^{-1} and NPK@ 40:60:20 kg ha^{-1}. Treatments were replicated thrice in split plot design. Raised sowing methods recorded highest plant height, number of leaves, number of primary and secondary branches and seed yield. An organic sources of nutrient FYM @ 15t ha^{-1} recorded significant effect on plant height, number of leaves, number of primary and secondary branches and seed yield

Keywords: vermicompost, raised, nutrient, replication, main plot

Introduction
Medicinal plant cultivation is becoming a tool for diversification of Indian agriculture as many farmers have been looking for some better alternative to diversify from traditional agriculture due to gradual reduction in profit, decline in productivity and increased incidence of diseases and pests. Cultivation of medicinal plants, especially high value medicinal plants is creating new dimension in the field of agriculture. Ashwagandha, the 3rd important prioritized medicinal plant listed by National Medicinal Plant Board (NMPB) is also known as Indian Ginseng**.** Ashwagandha is a small woody shrub or herb that grows or reaches about 30-150 cm in height belongs to the family Solanaceae. The stem and branches are covered with minute stellate hairs. Leaves are simple upto 10 cm long, ovate, pedicillate and alternate. Plant bears small (1cm long), greenish or yellow flowers borne together in short axillary clusters. The fruits or berries are smooth, spherical, yellow, red coloured with 6 mm diameter enclosed in an inflated and membranous calyx.

Material and methods
The study was under taken with a view to find out the effect of different sowing methods and organic sources of nutrient and their interaction on growth and yield of ashwagandha. The experiment was carried out during *rabi* seasion 2016-17 at college of agriculture, IGKV Raipur. There were eighteen combinations of three sowing methods in main plot flat bed, ridge bed and raised bed and six sub plots control, FYM @ 10 t ha^{-1}, FYM @15 t ha^{-1}, vermicompost @ 5 t ha^{-1}, vermicompost @ 7.5 t ha^{-1} and NPK 40:60:20 kg ha^{-1}. Treatments were replicated thrice in split plot design. All the data on plant height, number of leaves, number of primary and secondary branches and number of berries were recorded and statistically analyzed. Half dose of N and full dose of FYM, vermicompost, P, K were applied uniformly at sowing as a basal dose and remaining half of N was given as top dressed in two equal split. The allocation of these treatments was done randomly and all the cultural practices were followed as per recommended.

Results and Discussion

Plant height

Plant height is an important morphological character that acts as a potent indicator of availability of growth resources in its vicinity. The plant height was significantly influenced by sowing methods except at 30 DAS. The tallest plant (84.10 cm) was recorded with raised bed sowing method at harvest which might be due to better soil physical conditions better aeration, increased nutrient uptake, less leaching losses and lack of water stagnation led to higher crop growth rate under raised bed in comparison to flat bed, ridge and furrow method. Organic matter content is the major natural source of microbial energy. The raised bed sowing might have provided comparatively higher nutrient and water use efficiency and thereby triggered the vegetative growth Singh and Singh (2010) [2]. The plant height was significantly influenced by different organic sources of nutrient except at 30 DAS. The maximum plant height (87.36 cm) was observed with FYM @ 15 t ha^{-1} from 120 DAS to at harvest while minimum plant height (62.63 cm) which is at par during 90 DAS and at harvest and statically at par with FYM @ 10 t ha^{-1}. 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.

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

Treatment	Plant height (in cm)				
	30 DAS	60 DAS	90 DAS	120 DAS	At harvest
Main plot : Sowing methods (MS)					
M_1: Flat bed method	3.57	34.68	55.40	67.52	73.71
M_2: Ridge and furrow method	3.45	37.56	58.80	73.05	79.26
M_3: Raised bed method	3.86	41.04	65.29	77.18	84.10
SEm±	0.13	0.14	0.17	0.19	0.19
CD (P= 0.05%)	NS	0.58	0.70	0.77	0.77
Sub plot: Organic sources of nutrient (S)					
S_1: Control	3.63	28.59	35.33	41.88	62.63
S_2: FYM @ 10 t ha^{-1}	3.79	43.64	66.97	82.92	86.76
S_3: FYM @ 15 t ha^{-1}	3.75	45.43	68.46	83.92	87.36
S_4: Vermicompost @ 5 t ha^{-1}	3.47	33.24	60.36	73.78	7.09
S_5: Vermicompost @ 7.5 t ha^{-1}	3.54	41.13	66.40	77.85	81.72
S_6: NPK @ 40:60:20 kg ha^{-1}	3.54	34.54	61.61	75.54	78.57
SEm±	0.10	0.49	0.51	0.50	0.58
CD (P= 0.05%)	NS	1.41	1.49	1.44	1.69
Interaction (MS× S)	NS	S	S	S	S

Number of leaves $plant^{-1}$

Maximum number of leaves (174.03) was reported at harvest with raised bed sowing method. Raised bed planting was recorded significantly highest number of leaves might be due to better aeration led to higher crop growth rate. Singh and Singh (2010) [2] also reported that the raised bed sowing provided comparatively higher nutrient and water use efficiency and thereby triggered the vegetative growth. The different organic sources of nutrient were also showed significant for number of leaves in ashwagandha at each 30 days interval till harvest. The maximum number of leaves (188.02) was recorded at harvest with the application of FYM @ 15 t ha^{-1} which was at par over FYM @ 10 t ha^{-1} at all growth stages. This might due to organic matter content which is the major natural source of microbial energy. Joy *et al.* (2005) [3] reported that the maximum number of leaves in black mushli with the application of FYM 30 t ha^{-1}.

Table 2: Number of leaves of ashwagandha as influenced by sowing methods and organic sources of nutrient

Treatment	No. of leaves $plant^{-1}$				
	30 DAS	60 DAS	90 DAS	120 DAS	At harvest
Main plot : Sowing methods (MS)					
M_1: Flat bed method	6.38	52.49	148.68	158.59	167.91
M_2: Ridge and furrow method	6.48	55.62	152.76	161.84	168.87
M_3: Raised bed method	7.55	57.58	158.69	170.00	174.03
SEm±	0.09	0.57	1.48	1.28	0.91
CD (P= 0.05%)	0.36	2.65	5.82	5.06	3.59
Sub plot: Organic sources of nutrient (S)					
S_1: Control	5.22	36.20	114.85	145.57	151.84
S_2: FYM @ 10 t ha^{-1}	7.13	61.01	167.20	176.79	183.55
S_3: FYM @ 15 t ha^{-1}	8.21	63.56	170.8	177.74	188.02
S_4: Vermicompost @ 5 t ha^{-1}	6.49	54.73	150.24	156.18	162.74
S_5: Vermicompost @ 7.5 t ha^{-1}	6.96	60.25	161.20	168.52	174.76
S_6: NPK @ 40:60:20 kg/ha	6.80	55.64	155.91	156.06	160.72
SEm±	0.25	1.18	2.34	1.45	1.62
CD (P= 0.05%)	0.74	3.41	6.77	4.19	4.68
Interaction (MS × S)	S	S	S	S	S

Number of primary branches $plant^{-1}$

The highest number of primary branches (16.42) was recorded at harvest under raised bed sowing method whereas, lowest number of primary branches (14.92) with flat bed method. Nitrogen supplied through FYM and vermicompost which increase vegetative growth. Ashwagandha sown on

raised beds resulted in significantly higher number of primary branches at all growth stages which might be due to better soil physical conditions. It increased considerably with an increase in age after sowing and maximum number of primary branches (18.17) was recorded with the application of FYM 15 t ha^{-1}. Guleria *et al*. (2013) [1] reported that the maximum branches were found under vermicompost in aloe vera.

Table 3: Number of primary branches plant^{-1} of ashwagandha as influenced by sowing methods and organic sources of nutrient

Treatment	No. of primary branches plant^{-1}			
	60 DAS	90 DAS	120 DAS	At harvest
Main plot : Sowing methods (MS)				
M_1: Flat bed method	5.78	11.31	13.86	14.92
M_2: Ridge and furrow method	6.34	11.19	14.38	15.62
M_3: Raised bed method	6.96	12.69	15.12	16.42
SEm±	0.07	0.06	0.05	0.08
CD (P= 0.05%)	0.28	0.27	0.23	0.33
Sub plot: Organic sources of nutrient (S)				
S_1: Control	4.98	6.96	8.05	9.69
S_2: FYM @ 10 t ha^{-1}	6.88	13.48	16.35	17.47
S_3: FYM @ 15 t ha^{-1}	7.76	14.08	17.07	18.17
S_4: Vermicompost @ 5 t ha^{-1}	5.75	11.74	14.98	15.37
S_5: Vermicompost @ 7.5 t ha^{-1}	6.58	13.32	15.35	17.09
S_6: NPK @ 40:60:20 kg ha^{-1}	6.22	12.24	14.92	16.11
SEm±	0.12	0.14	0.14	0.14
CD (P= 0.05%)	0.36	0.41	0.40	0.40
Interaction (MS × S)	S	S	S	S

Number of secondary branches plant^{-1}

The highest number of secondary branches (10.63) was recorded at harvest under raised bed sowing method. Ashwagandha sown on raised beds resulted in significantly higher number of secondary branches at all growth stages which might be due to better soil aeration and suitable micro flora environment. It increased considerably with an increase in age after sowing the maximum number of secondary branches (11.06) was recorded with the application of FYM 15 t ha^{-1}.

Table 4: Number of secondary branches plant^{-1} of ashwagandha as influenced by sowing methods and organic sources of nutrient

Treatment	No. of secondary branches plant^{-1}			Seed yield kg ha^{-1}
	90 DAS	120 DAS	At harvest	
Main plot : Sowing methods (MS)				
M_1: Flat bed method	3.84	6.08	8.18	152.44
M_2: Ridge and furrow method	4.20	7.25	8.76	164.42
M_3: Raised bed method	5.09	8.69	10.63	182.21
SEm±	0.07	0.12	0.23	1.14
CD (P= 0.05%)	0.31	0.47	0.88	4.49
Sub plot: Organic sources of nutrient (S)				
S_1: Control	3.26	5.86	7.14	128.03
S_2: FYM @ 10 t ha^{-1}	5.01	8.64	9.75	194.36
S_3: FYM @ 15 t ha^{-1}	5.47	9.07	11.06	214.00
S_4: Vermicompost @ 5 t ha^{-1}	3.96	6.23	8.71	137.39
S_5: Vermicompost @ 7.5 t ha^{-1}	4.36	7.83	9.44	173.24
S_6: NPK @ 40:60:20 kg ha^{-1}	4.21	6.42	9.02	151.12
SEm±	0.10	0.17	0.27	2.84
CD (P= 0.05%)	0.30	0.50	0.80	8.21
Interaction (MS × S)	S	S	S	S

Seed yieldError! Bookmark not defined.

The maximum seed yield (182.21 kg ha^{-1}) was recorded from raised bed sowing method due to better transfer of photosynthetes to sink. Highest (214 kg ha^{-1}) seed yield was recorded with the application of FYM @ 15 t ha^{-1}.

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