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Phenological study and berries yield of Ashwagandha (*Withania somnifera* (L.) Dunal) as influenced by sowing method and organic sources of nutrients

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Abstract
Ashwagandha (*Withania somnifera* (L.) Dunal) is the member of nightshade family *i.e.* Solanaceae. It is an erect, herbaceous, evergreen, tomentose shrub. 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 leaf area, crop growth, net assimilation rate and berries yield. An organic sources of nutrient FYM @ 15t ha^{-1} recorded significant effect on leaf area, crop growth and net assimilation rate and berries yield.

Keywords: FYM, ridge, nutrient, replication, growth

Introduction
Ashwagandha, the 3rd important prioritized medicinal plant listed by National Medicinal Plant Board (NMPB) is also known as Indian Ginseng. There are considerable gap between demand and supply of medicinal land aromatic plant, which provide raw material to pharmaceutical industries. 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. It is found wild in grazing grounds in Mandsaur and Bastar district of Chhattisgarh, all over the foothills of the Punjab and Himachal Pradesh and Western Uttar Pradesh, in the Himalayas.

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 leaf area, crop growth, net assimilation rate and berries yield 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

Leaf area (cm^2)

There was a rapid growth in the leaf area plant^{-1} up to 120 DAS while maximum increase in leaf area was observed at 120 DAS. The maximum leaf area (652.75 cm^2 plant^{-1}) was recorded with raised bed which was significant other sowing methods at harvest. The raised bed sowing method was increased leaf area due to higher leaf length, leaf width and more number of leaves which produced maximum leaf area. Among the organic sources of nutrient, highest leaf area (738.79 cm^2 plant^{-1}) was recorded with application of FYM @ 15 t ha^{-1} than other organic sources of nutrient. The interaction effect between sowing methods and organic sources of nutrient for leaf area were found significant. The application of FYM increased leaf area due to creation of good tilth resulted in maintaining of ideal physical, chemical and biological properties of soil leads to optimum use of available soil nutrients which promotes vegetative growth of plants. Chandra *et al.* (2007) [1] reported that the double row raised bed method was significantly higher the leaf area of safed musli as compared to the triple row raised bed method and ridge and furrow.

Table 1: Leaf area (cm2) plant^{-1} of Ashwagandha as influenced by sowing method and organic sources of nutrient

Treatment	Leaf area (cm^2) plant^{-1}		
	90 DAS	120 DAS	At harvest
Main plot : Sowing methods (MS)			
M_1: Flat bed method	517.23	625.04	612.82
M_2: Ridge and furrow method	523.86	639.43	629.57
M_3: Raised bed method	532.55	652.75	641.22
SEm±	0.50	1.28	1.05
CD (P= 0.05%)	1.98	4.86	4.14
Sub plot: Organic sources of nutrient (S)			
S_1: Control	345.64	435.29	432.58
S_2: FYM @ 10 t ha^{-1}	578.30	729.81	725.14
S_3: FYM @ 15 t ha^{-1}	620.91	738.79	736.89
S_4: Vermicompost @ 5 t ha^{-1}	520.85	629.66	619.21
S_5: Vermicompost @ 7.5 t ha^{-1}	553.52	645.71	628.22
S_6: NPK @ 40:60:20 kg ha^{-1}	528.06	638.00	620.52
SEm±	0.80	2.06	0.79
CD (P= 0.05%)	2.31	5.96	2.28
Interaction (MS × S)	S	S	S

Crop growth rate (g $m^{-2}day^{-1}$)

The crop growth rate was affected significantly due to different sowing methods. The raised bed sowing was increased crop growth rate due to high photosynthetic production, higher leaf length, leaf width and more number of leaves which produced maximum leaf area and contribute more dry matter accumulation and availability of all growth resources and which was superior over flat bed sowing method. The crop growth rate was increases with age of Ashwagandha. Crop growth rate of Ashwagandha was significantly influenced by organic sources of nutrient. Higher crop growth rate was recorded under FYM @ 15 t ha^{-1}. The interaction effect between sowing methods and organic sources of nutrient for crop growth rate were found significant. Application of FYM increased crop growth rate due to optimum use of available soil nutrients which promotes vegetative growth of plants.

Table 2: Crop growth rate (g $m^{-2}day^{-1}$) of Ashwagandha as influenced by sowing methods and organic sources of nutrient

Treatment	CGR (g $m^{-2}day^{-1}$)			
	60 DAS	90 DAS	120 DAS	At harvest
Main plot : Sowing methods (MS)				
M_1: Flat bed method	0.14	2.67	14.21	18.14
M_2: Ridge and furrow method	0.40	2.89	14.68	18.24
M_3: Raised bed method	0.54	3.20	15.24	19.43
SEm±	0.04	0.04	0.15	0.07
CD (P= 0.05%)	0.14	0.17	0.59	0.28
Sub plot: Organic Sources of nutrient (S)				
S_1: Control	0.07	1.66	8.20	11.28
S_2: FYM @ 10 t ha^{-1}	0.62	3.37	16.70	20.70
S_3: FYM @ 15 t ha^{-1}	0.83	3.69	17.62	22.96
S_4: Vermicompost @ 5 t ha^{-1}	0.13	3.03	14.84	18.30
S_5: Vermicompost @ 7.5 t ha^{-1}	0.40	3.05	15.57	20.56
S_6: NPK @ 40:60:20 kg ha^{-1}	0.10	2.91	15.33	17.83
SEm±	0.08	0.12	0.17	0.50
CD (P= 0.05%)	0.23	0.36	0.49	1.46
Interaction (MS × S)	S	S	S	S

Net assimilation rate (g m^{-2} day^{-1})

Among the different sowing methods, the raised bed method was found superior as far as the net assimilation rate point of views. The highest (11.35 g m^{-2} day^{-1}) value of net assimilation rate was obtained from raised bed sowing method which is superior over at all growth stages of observations. The raised bed sowing was increased crop growth rate due to higher leaf length, leaf width and more number of leaves which produced maximum leaf area and contribute more dry matter accumulation and availability of all growth resources and lower (10.11 g m^{-2} day^{-1}) in the flat bed sowing method. Net assimilation rate of Ashwagandha was significantly influenced by organic sources of nutrient. Higher crop growth rate (12.37 g m^{-2} day^{-1}) was recorded under FYM @ 15 t ha^{-1} at 120 DAS which was superior over other source of nutrient and their levels. The interaction effect between sowing methods and organic sources of nutrient for net assimilation rate was found significant. The application of FYM produced higher crop growth rate due to maintaining of ideal physical, chemical and biological properties of soil leads to optimum use of available soil nutrients.

Berries yield (plant^{-1})

The maximum number of berries (403.09) was recorded in raised bed method this might be due to maximum photosynthates are translocated to sink. The number of berries plant^{-1} was significantly influenced by organic sources of nutrient. Number of berries plant^{-1} was superior with the application of FYM @ 15 t ha^{-1} followed by application of FYM @ 10 t ha^{-1}. Kumar and Singh (2014) found that raised bed sowing significantly increased the growth attributes like number of pods plant^{-1}, rajmash as compared to flat bed method of sowing.

Table 3: Net assimilation rate and berries yield plant^{-1} of Ashwagandha as influenced by sowing methods and organic sources of nutrient

Treatment	Net Assimilation Rate (g m^{-2} day^{-1})		Berries yield plant^{-1}
	90 DAS	120 DAS	
Main plot : Sowing methods (MS)			
M_1: Flat bed method	8.33	10.11	326.65
M_2: Ridge and furrow method	8.69	10.69	356.36
M_3: Raised bed method	8.93	11.35	403.09
SEm±	0.11	0.06	9.34
CD (P= 0.05%)	0.39	0.25	36.69
Sub plot: Organic sources of nutrient (S)			
S_1: Control	6.93	8.80	244.43
S_2: FYM @ 10 t ha^{-1}	9.55	11.72	397.02
S_3: FYM @ 15 t ha^{-1}	9.80	12.37	438.02
S_4: Vermicompost @ 5 t ha^{-1}	7.95	9.96	338.83
S_5: Vermicompost @ 7.5 t ha^{-1}	9.21	11.10	393.50
S_6: NPK @ 40:60:20 kg ha^{-1}	8.45	10.36	360.58
SEm±	0.09	0.14	7.45
CD (P= 0.05%)	0.29	0.40	21.53
Interaction (MS × S)	S	S	S

References

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