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The impact of organic manures and moisture conservation practices on growth and development of shoot and root of Ashwagandha

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ABSTRACT
The application of an integrated plant nutrient supply system is becoming popular as it is scientifically sound and assures sustainable development in agriculture. The use of judicious combination of organic and inorganic fertilizer source is essential not only to maintain soil health but also sustain productivity. The importance of organic manures to enhance the quantity and quality components has to be further studied in Ashwagandha with decrease rates in applied quantities of inorganic manures which seems to reduce the cost of production to maximize the yield upto optimum levels to that of synthetic fertilizers
Keywords: *Ashwagandha, inorganic manures*

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INTRODUCTION

Ashwagandha,(*Withania somnifera* Dunal) belong to the family (Solanaceae), known as "Indian ginseng" is a reputed medicinal herb grown for its roots in arid and semi-arid regions of many countries. Roots of this plant form ingredients of many herbal formulations prescribed for musculoskeletal conditions, nervous system and as a general health tonic for elderly persons and lactating mothers [1-3]. It is an erect growing, branching shrub with a normal height of 1.50 m. Ashwagandha is a dryland medicinal crop having tremendous marketing potential owing to demand of its roots to the tune of 7000 tonnes and estimated production of 1500 tonnes [4-11].

The application of inorganic nutrients may not significantly influenced the various economic traits in contradiction due to the fact that bio-synthesis of secondary metabolites is under genetic control to influence plant growth and seed yield in various responsive crops including Ashwagandha but the development of a reliable and consistent inoculation technology deter mines that the application of Azospirillum, FYM and Vermicompost, inter action beneficial with regards to a biological model for fundamental studies on symbiotic associations between them to have a significant impact in future agricultural production [12-16].

MATERIAL AND METHODS

Location of the experiment

The field experiment entitled "Impact of different manures and moisture conservation practices on Ashwagandha (Withania somnifera Duanal) Production under rainfed condition" was carried out from August 2013 to April 2014 at sandy loam soil at field No. A-4 of Herbal Research Farm, Department of Soil Conservation & Water Management /Forestry, Chandra Sekhar Azad University of Agriculture & Technology, Kanpur.The experiment site is situated at an altitude of 125.9 m above mean sea level with a geographical bearing of 25o 28' North latitude and 79o 1' East longitude.

The experiment was laid out in Randomized block design (RBD) with three replications. The eighteen treatments consisted of Absolute control (No manures, biofertilizers and inorganic fertilizers) , Hoeing +

Weeding , Organic mulch , FYM @ 20 t ha-1 , FYM @ 20 t ha-1 + Hoeing + Weeding , FYM @ 20 t ha-1 + Organic mulch , Vermicomposting @ 5 t ha-1 , Vermicomposting @ 5 t ha-1 + Hoeing + Weeding , Vermicomposting @ 5 t ha-1 + Organic mulch , FYM @ 10 t ha-1 + Vermicomposting @ 2.5 t ha-1 , FYM @ 10 t ha-1 + Vermicomposting @ 2.5 t ha-1 + Hoeing + Weeding , FYM @ 10 t ha-1 + Vermicomposting @ 2.5 t ha-1 + Organic mulch , FYM @ 10 t ha-1 + Vermicomposting @ 2.5 t ha-1 + PSB @ 2 kg ha-1 + Azotobactor @ 2 kg ha-1 , FYM @ 10 t ha-1 + Vermicomposting @ 2.5 t ha-1 + PSB @ 2 kg ha-1 + Azotobactor @ 2 kg ha-1+ Hoeing + weeding , FYM @10 t ha-1 + Vermicomposting @ 2.5 t ha-1 + PSB @ 2 kg ha-1 + Azotobactor @ 2 kg ha-1 + Organic mulch , Recommended dose of fertilizers N and P @ 20 : 40 kg ha-1 , Recommended dose of fertilizers N and P @ 20 : 40 kg ha-1 + Hoeing + Weeding and Recommended dose of fertilizers N and P @ 20 : 40 kg ha-1 + Organic mulch.

RESULTS

Plant height (cm)

The plant height of Ashwagandha was significantly influenced by fertility levels and moisture conservation practices at different stages of crop growth (Table 1).

At 60, 90, 120, 150 DAS and harvest stage, the plant height significantly influenced by fertility levels and moisture conservation practices. The application of FYM @10 t ha-1 + vermicompost @ 2.5 t ha-1 + PSB @ 2 kg ha-1 + azotobactor @ 2 kg ha-1recorded treatment of F5 the highest plant height (39.41 cm) at harvest stage followed treatment of F4 application of FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1(38.10 cm) while minimum plant height was recorded of treatment F1 control (30.06 cm) under fertility levels. Among the moisture conservation practices the highest plant height was recorded treatment of M2 with hoeing and weeding (36.63 cm) followed treatment of M3 organic mulch (35.38 cm) while lowest plant height was recorded with treatment of M1 control (34.92 cm) at harvest stage.

Table 1: Effect of organic manures and Fertilizers on plant height (cm) at different stages of crop growth in Ashwagandha (*Withaniasomnifera* Dunal.)

TREATMENTS	Days after sowing				
	60	90	120	150	Harvest
Fertility levels					
F_1	9.68	12.95	23.49	31.37	30.06
F_2	11.11	14.83	26.29	35.21	36.41
F_3	11.41	15.22	26.99	36.09	37.34
F_4	11.59	15.53	27.45	36.78	38.10
F_5	12.29	16.07	28.49	37.81	39.41
F_6	10.21	14.48	24.72	32.03	32.56
S.E± (d)	**0.354**	**0.48**	**0.58**	**0.81**	**0.94**
C.D (P=0.05)	**0.72**	**0.98**	**1.19**	**1.66**	**1.18**
Moisture conservation practices					
M_1	10.61	14.34	25.55	34.02	34.92
M_2	11.43	15.29	26.73	35.22	35.38
M_3	11.09	14.92	26.48	35.41	36.63
S.E± (d)	**0.25**	**0.34**	**0.41**	**0.57**	**0.66**
C.D (P=0.05)	**0.50**	**0.69**	**0.84**	**1.17**	**1.33**

Number of Branches

The number of branches plant-1 in Ashwagandha was significantly influenced by fertility levels and moisture conservation practices levels at different stages of crop growth (fig. 1).

At 60, 90, 120, 150 DAS and harvest stage, the number of branches plant-1 significantly influenced by fertility levels and moisture conservation practices. The application of FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1 + PSB @ 2 kg ha-1 + azotobactor @ 2 kg ha-1 recorded of treatment F4 the highest number of branches (11.21) at harvest stage followed by FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1 of treatment F5 (10.81) while minimum number of branches -was recorded with treatment F1 (5.51) under control.

Among the moisture conservation practices the highest number of branches was recorded with treatment

of M3 organic mulch (10.52) treatment M2 of hoeing and weeding (10.00) and lowest number of branches was recorded with treatment M1 of control (8.62) at harvest stage.

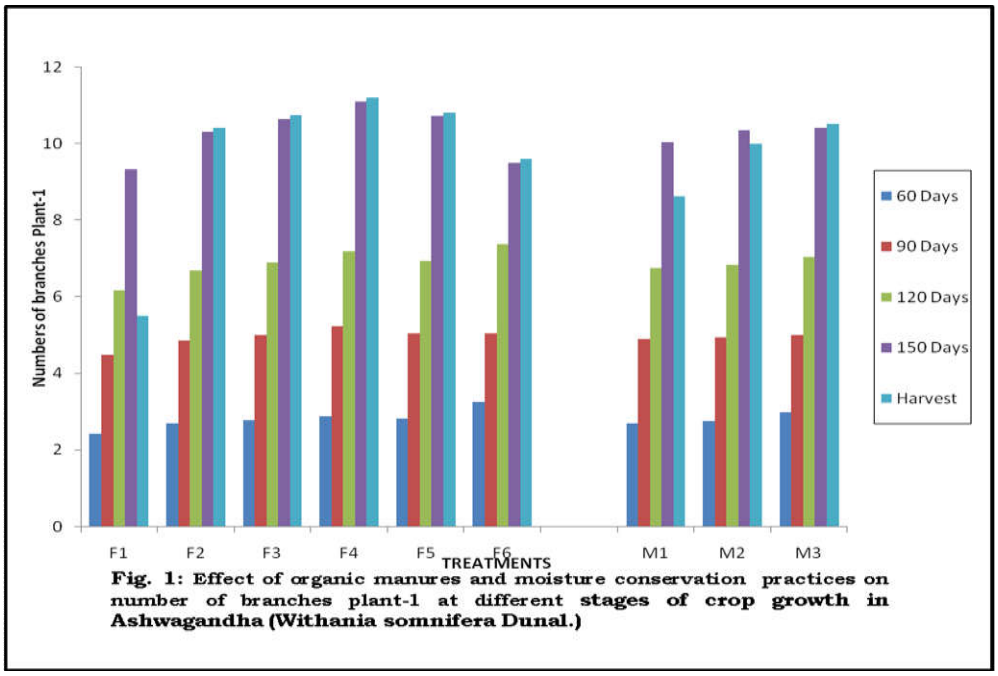

Fig. 1: Effect of organic manures and moisture conservation practices on number of branches plant-1 at different stages of crop growth in Ashwagandha (Withania somnifera Dunal.)

Leaf fresh weight (g plant-1)

The leaf fresh weight (g plant-1) in Ashwagandha was significantly influenced by fertility levels and moisture conservation practices levels at different stages of crop growth .

The leaf fresh weight registered a progressive increase from 60 to 90 DAS and maximum increase in leaf fresh weight was recorded between 90 to 120 DAS however from 120 DAS to harvest it decrease under all the fertility levels.

The application of FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1 + PSB @ 2 kg ha-1 + azotobactor @ 2 kg ha-1under treatment F4 recorded highest leaf fresh weight (47.93 g) at harvest stage followed by treatment F5 FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1 (45.73 g). The minimum leaf fresh weight was recorded in treatment F1 of control (37.03 g) under fertility levels.

Among moisture conservation practices the highest leaf fresh weight was recorded under treatment M3 of organic mulch (46.16 g) followed by M2 of hoeing and weeding (42.52 g) while lowest leaf fresh weight was recorded with M1 of control (39.29 g) at harvest stage.

Leaf dry weight (g plant-1)

At all the successive stage, leaf dry weight of Ashwagandha was significantly influenced by fertility levels and moisture conservation practices at different stages of crop growth (Table 2).

The leaf dry weight registered a progressive increase from 60 to 120 DAS after which there was a steep decrease in dry weight of leaves up to harvest under all fertility levels.

At harvest, the leaf dry weight was significantly affected by fertility levels and moisture conservation practices. The application of FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1 + PSB @ 2 kg ha-1 + azotobactor @ 2 kg ha-1in treatment F5 recorded the highest leaf dry weight (7.72 g) at harvest stage followed by F4 of FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1(7.43 g). The minimum leaf dry weight was recorded under F1 of control (5.82 g) under fertility levels.

Among the moisture conservation practices the highest leaf dry weight was recorded with treatment M3 of organic mulch (7.32 g) followed by M2 of hoeing and weeding (6.83 g) while lowest leaf dry weight was recorded under M1 of control (6.18 g) at harvest stage.

Table 2: Effect of organic manures and moisture conservation practices on leaf fresh weight (g plant^{-1}) at different stages of crop growth in Ashwagandha (*Withaniasomnifera* Dunal.)

TREATMENTS	Days after sowing				
	60	90	120	150	Harvest
Fertility levels					
F_1	5.53	29.65	57.08	49.14	37.03
F_2	6.41	34.38	65.92	56.98	42.92
F_3	6.60	35.40	67.89	58.66	44.20
F_4	7.06	37.86	72.60	62.74	47.93
F_5	7.21	38.35	73.58	62.56	45.73
F_6	5.70	30.35	58.56	50.58	38.12
S.E± (d)	**0.12**	**0.40**	**0.79**	**0.93**	**0.98**
C.D (P=0.05)	**0.24**	**0.83**	**1.61**	**1.90**	**2.00**
Moisture conservation practices					
M_1	5.91	31.41	60.23	52.03	39.29
M_2	6.43	34.60	66.57	57.35	42.52
M_3	6.92	36.93	71.01	60.95	46.16
S.E± (d)	**0.08**	**0.28**	**0.56**	**0.66**	**0.69**
C.D (P=0.05)	**0.17**	**0.58**	**1.14**	**1.34**	**1.41**

Shoot fresh weight (g plant-1)

The shoot fresh weight of Ashwagandha was remarkably varied with fertility levels and moisture conservation practices at different stages of crop growth.

The shoot fresh weight significantly influenced by fertility levels and moisture conservation practices at the stages. While the shoot fresh weight registered a progressive increase from 60 to 120 DAS afterward there was a steep decrease in shoot fresh weight at harvest under different fertility levels.

Finally, the shoot fresh weight was significantly affected by fertility levels and moisture conservation practices. In F5 when we apply FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1 + PSB @ 2 kg ha-1 + azotobactor @ 2 kg ha-1 recorded the highest shoot fresh weight (30.05g) at harvest stage followed by F4 of FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1 (24.13 g) while minimum shoot fresh weight was recorded in F1 of control (20.02 g).

In context to moisture conservation practices the highest shoot fresh weight was recorded in M3 with organic mulch (24.38 g) followed by M2 of hoeing and weeding (23.70g). The lowest shoot fresh weight was recorded in M1 of control (22.04 g) at harvest stage.

Shoot dry weight (g plant-1)

The shoot dry weight of Ashwagandha was significantly influenced by different fertility levels and moisture conservation practices at different stages of crop growth (Table 3). The shoot dry weight registered a progressive increase from 60 to 120 DAS thereafter drastically decrease in shoot dry weight at harvest under different fertility levels.

In F5 treatment the application of FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1 + PSB @ 2 kg ha-1 + azotobactor @ 2 kg ha-1 recorded the highest shoot dry weight (13.05 g) at harvest stage followed treatment F4 in FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1 (9.50 g) while minimum shoot dry weight was recorded in F1with control (8.26 g) among all fertility levels.

Among the moisture conservation practices the highest shoot dry weight was recorded in M3 treatment of organic mulch (10.18 g) followed by M2 of hoeing and weeding (9.84 g). The lowest shoot dry weight was recorded with treatment M1 of control (9.27 g) at harvest stage.

Table 3: Effect of organic manures and moisture conservation practices on shoot dry weight (g plant^{-1}) at different stages of crop growth in Ashwagandha (*Withania somnifera* Dunal.)

TREATMENTS	Days after sowing				
	60	90	120	150	Harvest
Fertility levels					
F_1	0.30	3.38	11.31	8.41	8.26
F_2	0.38	3.50	11.65	9.10	8.95
F_3	0.37	3.58	12.13	9.54	9.40
F_4	0.42	3.65	12.35	9.70	9.50
F_5	0.47	4.94	17.10	13.35	13.05
F_6	0.36	3.38	12.26	9.66	9.43
S.E± (d)	**0.02**	**0.11**	**0.31**	**0.18**	**0.19**
C.D (P=0.05)	**0.04**	**0.24**	**0.64**	**0.38**	**0.39**
Moisture conservation practices					
M_1	0.27	3.34	11.90	9.57	9.27
M_2	0.39	3.81	12.99	10.02	9.84
M_3	0.48	4.07	13.50	10.38	10.18
S.E± (d)	**0.01**	**0.08**	**0.22**	**0.13**	**0.13**
C.D (P=0.05)	**0.03**	**0.17**	**0.45**	**0.27**	**0.28**

Root length per plant (cm)

The root length plant-1of Ashwagandha was significantly differed by fertility levels and moisture conservation practices at different stages of crop growth (Table 4).

All the stages of crop growth, the root length plant-1 significantly influenced by fertility levels and moisture conservation practices. The application of FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1 + PSB @ 2 kg ha-1 + azotobactor @ 2 kg ha-1 recorded in treatment F4 of the highest root length plant-1 (18.13 cm) at harvest stage followed by treatment F3 of FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1 (17.63 cm). The minimum root length plant-1 was recorded with control treatment F1 of (11.08 cm) under fertility levels.

Among the moisture conservation practices the highest root length plant-1 was recorded under treatment M3 of organic mulch (15.76 cm) followed by M2 hoeing and weeding (15.10 cm). The lowest root length plant-1 was recorded in treatment M1 of control (14.00 cm) at harvest stage.

Table 4: Effect of organic manures and moisture conservation practices on length of root per plant (cm) at different stages of crop growth in Ashwagandha (*Withania somnifera* Dunal.)

TREATMENTS	Days after sowing				
	60	90	120	150	Harvest
Fertility levels					
F_1	3.50	5.78	7.48	8.60	11.08
F_2	4.50	6.87	8.76	10.37	13.70
F_3	4.75	7.00	9.14	12.16	17.63
F_4	4.72	8.28	10.85	13.30	18.13
F_5	5.86	8.97	11.39	11.78	17.10
F_6	4.51	7.90	9.75	10.12	12.10
S.E± (d)	**0.11**	**0.20**	**0.25**	**0.29**	**0.33**
C.D (P=0.05)	**0.22**	**0.42**	**0.51**	**0.59**	**0.68**
Moisture conservation practices					
M_1	4.43	6.97	8.83	10.25	14.00
M_2	4.67	7.51	9.68	11.16	15.10
M_3	4.82	7.92	10.15	11.76	15.76
S.E± (d)	**0.07**	**0.14**	**0.7**	**0.20**	**0.23**
C.D (P=0.05)	**0.16**	**0.29**	**0.36**	**0.41**	**0.48**

Root girth per plant (cm)

The root girth plant-1of Ashwagandha was significantly enhanced with fertility levels and moisture conservation practices at different stages of crop growth (Table 5).

At all the stage, the root girth plant-1 significantly influenced by fertility levels and moisture conservation practices. The application of FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1 + PSB @ 2 kg ha-1+ azotobactor @ 2 kg ha-1 under treatment F4 recorded the highest root girth plant-1 (2.87 cm) at harvest stage followed by treatment F3 of FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1 (2.84 cm). The minimum root girth plant-1 was recorded with F1 of traditional practices control (2.69 cm) under fertility levels.
Among the moisture conservation practices the highest root girth plant-1 was recorded treatment M3 of organic mulch (3.31 cm) followed by M2 of hoeing and weeding (3.13 cm) while lowest root girth plant-1 was recorded under M1 of control (2.92 cm) at harvest stage.

Table 5:Effect of organic manures and moisture conservation practices on girth of root (cm) plant^{-1} at different stages of crop growth in Ashwagandha (*Withania somnifera* Dunal.

TREATMENTS	Days after sowing				
	60	90	120	150	Harvest
Fertility levels					
F_1	1.07	2.18	2.52	2.57	2.69
F_2	1.14	2.33	2.81	2.72	2.83
F_3	1.19	2.30	2.82	2.74	2.84
F_4	1.23	2.61	3.21	2.76	2.87
F_5	1.70	4.38	4.88	4.61	4.72
F_6	1.16	2.20	2.92	2.66	2.78
S.E± (d)	**0.22**	**0.04**	**0.15**	**0.09**	**0.09**
C.D (P=0.05)	**0.04**	**0.10**	**0.32**	**0.19**	**0.18**
Moisture conservation practices					
M_1	1.19	2.54	3.01	2.81	2.92
M_2	1.25	2.68	3.21	3.01	3.13
M_3	1.30	2.77	3.35	3.21	3.31
S.E± (d)	**0.01**	**0.03**	**0.11**	**0.06**	**0.06**
C.D (P=0.05)	**0.03**	**0.07**	**0.22**	**0.13**	**0.12**

CONCLUSION

At harvest, the application of FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1 + PSB @ 2 kg ha-1 + azotobactor @ 2 kg ha-1 of treatment F5 (39.41 cm) recorded the highest plant height and lowest plant height was recorded with treatment of F1 control (30.06 cm) under fertility levels. Under moisture conservation practices, the highest plant height was recorded with treatment of M2 hoeing and weeding (36.63 cm) and lowest plant height was recorded under treatment of M1 control (34.92 cm).

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