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To study the effect of moisture conservation practices and nutrient uptake on ashwagandha

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Abstract
Among all fertility levels, the highest total water used by application of FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1 + PSB @ 2 kg ha-1 + azotobactor 2 kg ha-1 treatment in F5 of (316.1 mm) followed by treatment of F4 FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1 (310.9 mm) and lowest total water used in treatment F1 of control (304.4 mm). In case of moisture conservation practices, the highest water use in treatment M3 of organic mulch (314.2 mm) followed by treatment M2 of hoeing and weeding (312.1 mm) while lowest total water used in treatment M1 of control (310.6 mm), In context to moisture conservation practices.

Keywords: Fertility levels, moisture conservation, water use etc

Introduction
It is grown as rainfed crop in many parts of India under arid and semi-arid regions. It grows well in soils having residual moisture and single or two supplementary irrigations during the entire period of its growing season. Despite its drought tolerance capacity, prolonged soil moisture deficit inhibits the growth and development of the crop and adversely affects the crop yield potential and plant productivity. Understanding the effect of long duration moisture stress on the active principle content and root quality will help to augment functional characterization and biochemical integration of molecular and genetic data. The objectives of this study were to understand the response of field grown W. somnifera to soil moisture deficit and the changes in root secondary metabolites productivity.
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 as reported by Umrao *et al*. (2008) 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.

Methods and materials
The field experiment 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 altitute of 125.9 m above mean sea level with a geographical bearing of 25o 28' North altitute and 79o 1' East longitute.

Plant analysis
The plant samples collected and at final harvest for computing dry matter production were utilized for the purpose for analysis of nitrogen, phosphorus and potassium. The leaves and shoot of the plant samples were dried at 60 ^{0}C till constant weights were obtained and powdered with the help of Electronic Grinder. The procedure for the analysis of nutrients are furnished below.

Nitrogen (%): The nitrogen content (%) in the dried plant samples was determined by Micro kjeldhal distillation method after digesting the organic matter by H_2O_2 (AOAC, 1960) and expressed as percent nitrogen on dry weight basis.

Phosphorus (%): The plant samples were digested with a triacid mixture consisting of HNO_3: H_2SO_4: $HCLO_4$ (9:4:1). The volume of digest was made up to 100ml. Phosphorus content in triacid digest was determined by the development of yellow colour with Barton's reagent. The intensity of yellow colour was determined by using UV visible spectrophotometer at 640 nm (AOAC, 1960).

Potassium (%): The 'K' content in triacid digest was determined by using ELICO Model 22 A Flame Photometer (AOAC, 1960).

3.8.4 Uptake of nutrients:
The uptake of nutrients like N, P and K at different stages was compiled using data on nutrients contents and dry matter yields.

$$\text{Nutrient uptake}(\text{kg ha}^{-1}) = \frac{\%\ \text{Nutrient content x Dry matter yield}(\text{kg ha}^{-1})}{100}$$

Results

Nutrient uptake

Nitrogen uptake (kg ha-1)

It is evident from (Table 1) that the nitrogen uptakeat harvest of the crop was significantly influenced by fertility levels and moisture conservation practices.

The highest nitrogen uptake at harvest was recorded by application of FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1 + PSB @ 2 kg ha-1 + azotobactor @ 2 kg ha-1 treatment of F5 (87.09 kg) followed by FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1 treatment of F4 (71.48 kg) while lowest nitrogen uptake was recorded treatment of F1 control (33.18 kg) under fertility levels.

At harvest, under moisture conservation practices, the highest nitrogen uptake was recorded by application of treatment of M3 organic mulch (63.04 kg ha-1) followed by M2of hoeing and weeding (61.83 kg ha-1) and treatment M1of control (60.09 kg ha-1).

Phosphorus uptake (kg ha-1)

It is evident from (Table 1) that the Phosphorus uptake at harvest of the crop was significantly influenced by fertility levels and moisture conservation practices levels.

The highest Phosphorus uptakeat harvest was recorded by application of FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1 + PSB @ 2 kg ha-1 + azotobactor @ 2 kg ha-1 treatment of F5 (28.41 kg ha-1) followed by FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1 treatment of F4 (23.26 kg ha-1) however lowest Phosphorus uptake was recorded treatment F1of control (8.65 kg ha-1) under fertility levels.

At harvest, under moisture conservation practices, the highest Phosphorus uptake was recorded treatment of M3 application of organic mulch (20.25 kg ha-1) followed by treatment M2 of hoeing and weeding (18.99 kg ha-1) and control (M1) (17.32 kg ha-1).

Potassium uptake (kg ha-1)

It is clear from (Table 1) that the potassium uptake at harvest of the crop was remarkably varied by fertility levels and moisture conservation practices.

The highest potassium uptake at harvest was recorded treatment of F5 application of FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1 + PSB @ 2 kg ha-1 + azotobactor @ 2 kg ha-1 (91.36 kg ha-1) followed by treatment of F4 FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1 (68.03 kg ha-1) however lowest potassium uptake was recorded treatment F1of control (22.70 kg ha-1) under fertility levels.

Under moisture conservation practices, the highest potassium uptake was recorded in M3by application of organic mulch (59.07 kg ha-1) followed by M2 of hoeing and weeding (57.35 kg ha-1) and M1 of control (55.02 kg ha-1) at harvest.

Table 1: Effect of organic manures and moisture conservation practices on nutrient uptake (kg ha^{-1}) at harvest stages of crop growth in Ashwagandha (*Withania somnifera* Dunal.)

Treatments	Nutrient uptake (kg ha^{-1})		
	N	P	K
Fertility levels			
F_1	33.18	8.65	22.70
F_2	48.70	13.17	38.23
F_3	61.28	18.80	57.68
F_4	71.48	23.26	68.03
F_5	87.09	28.41	91.36
F_6	68.18	20.83	64.88
S.E ±(d)	0.76	0.45	0.87
C.D (0.05)	1.55	0.92	1.78
Moisture conservation practices			
M_1	60.09	17.32	55.02
M_2	61.83	18.99	57.35
M_3	63.04	20.25	59.07
S.E± (d)	0.53	0.32	0.62
C.D (0.05)	1.09	0.65	1.26

Moisture studies

Effect of organic manures and moisture conservation practices on Total water use (mm)

Data on total water used summarized in (Table 2). The data revealed that different fertility levels and moisture conservation practices showed the total moisture used. The highest water used by application of FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1 + PSB @ 2 kg ha-1 + azotobactor 2 kg ha-1 treatment of F5 (316.1 mm) followed by treatment of F4 FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1 (310.9 mm) while lowest water used in treatment F1 of control (304.4 mm) among all fertility levels.

In moisture conservation practices, the highest water use in treatment of M3 organic mulch (314.2 mm) followed by treatment of M2 hoeing and weeding (312.1 mm) while lowest water used in treatment of M1 control (310.6 mm).

Effect of organic manures and moisture conservation practices on Water Use Efficiency (WUE) (kg roots/ha/mm)

Data on water use efficiency (WUE) have been summarized in (Table.2). The highest total water use efficiency was observed with treatment of F5 FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1 + PSB @ 2 kg ha-1 + azotobactor 2 kg ha-1 (2.98) followed by treatment of F4 FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1 (2.32) while lowest total water use efficiency was observed with treatment of F1 control (1.01), among all fertility levels.

In context to moisture conservation practices, the highest total water use efficiency with treatment of M3 organic mulch (2.34) followed by treatment of M2 hoeing and weeding (1.99) while lowest total water use efficiency was recorded with treatment of M1 control (1.61).

Table 2: Effect of organic manures and moisture conservation practices on total water use (mm) and water use efficiency (kg roots/ha/mm) on Ashwagandha (*Withania somnifera* Dunal.)

Treatments	Total water use (mm)	Root yield (q ha^{-1})	Water use efficiency (kg root/ha/mm)
Fertility levels			
F_1	304.4	3.10	1.01
F_2	308.60	6.02	1.95
F_3	306.8	6.83	2.22
F_4	310.9	7.24	2.32
F_5	316.1	9.45	2.98
F_6	306.0	4.57	1.49
Moisture conservation practices			
M_1	310.6	5.02	1.61
M_2	312.1	6.23	1.99
M_3	314.2	7.36	2.34

Economics

The data pertaining to cost of cultivation, total income, net returns and benefit cost ratio are presented in (Table 3).

Total Income (Rs. ha-1)

The highest total income (Rs.113400, ha-1) were obtained F5 with application of FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1 + PSB @ 2 kg ha-1 + azotobactor @ 2 kg ha-1 (F4) followed by FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1 (F3) (Rs. 86880 ha-1) however, the total lowest income was recorded by control (F1) (Rs 37,200 ha-1) under fertility levels.

Under moisture conservation practices, highest income was obtained in M3 treatment with organic mulch (Rs. 88320 ha-1) followed by M2 of hoeing and weeding (Rs.74760 ha-1) and lowest income was recorded with M1 of control (Rs.60240 ha-1).

Net Returns (Rs. ha-1)

The highest net returns (Rs,80611 ha-1) were obtained with application of FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1 + PSB @ 2 kg ha-1 + azotobactor @ 2 kg ha-1 (F5) followed F4 by FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1 (Rs.54244 ha-1) while total lowest net returns was obtained in F1 with control (Rs.15484 ha-1) among all fertility levels.

Under moisture conservation practices, highest net returns was obtained with M3 organic mulch (Rs.57083 ha-1) followed by M2 hoeing and weeding of (Rs.44843 ha-1) and lowest net returns was M1 control obtained in (Rs.33363 ha-1).

Benefit Cost Ratio

Application of FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1 + PSB @ 2 kg ha-1 + azotobactor @ 2 kg ha-1 F5 gave highest benefit cost ratio (2.45) followed by FYM @ 10 t ha-1 + vermicompost @ 2.5 t ha-1 F4 of (1.66) while lowest benefit cost ratio was received under F1 of control (0.71) under fertility levels.

Among moisture conservation practices, highest benefit cost ratio was obtained with organic mulch M3 of (1.82) followed by M2 of hoeing and weeding (1.49) and lowest benefit cost ratio was received in control M1 of (1.24).

Table 3: Total income, Net Return (Rs.ha^{-1}) and Benefit Cost Ratio influenced by organic manures and moisture conservation practices in Ashwagandha (*Withania somnifera* Dunal.)

Treatment	Yield (q ha^{-1})	Cost of cultivation	Total Income (Rs. ha^{-1})	Net Returns (Rs. ha^{-1})	Benefit : Cost Ratio
Fertility levels					
F_1	3.10	21716	37200	15484	0.71
F_2	6.02	32916	72240	39324	1.19
F_3	6.83	32082	81960	49878	1.55
F_4	7.24	32636	86880	54244	1.66
F_5	9.45	32789	113400	80611	2.45
F_6	4.57	23926	54840	30914	1.29
Moisture conservation practices					
M_1	5.02	26877	60240	33363	1.24
M_2	6.23	29917	74760	44843	1.49
M_3	7.36	31237	88320	57083	1.82

Conclusions

The highest N, P and K uptake kg ha-1 was recorded with 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 (87.09, 28.41 and 91.36 kg ha-1) respectively. The lowest N, P and K uptake was recorded with treatment of F1 control (33.18, 8.65 and 22.70 kg ha-1) respectively under fertility level at the time of harvesting of ashwagandha crop. Under moisture conservation practices, the maximum N, P and K uptake was observed in treatment M3 of organic mulch (63.04, 20.25 and 59.07 kg ha-1), respectively. The minimum N, P and K uptake was recorded with treatment M1 of control (60.09, 17.32 and 55.02 kg ha-1), respectively.

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