Plant Archives Vol. 14 No. 1, 2014 pp. 373-377 *ISSN 0972-5210*

INTEGRATED NUTRIENT MANAGEMENT IN ASHWAGANDHA (*WITHANIA SOMNIFERA* DUNAL.)

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Abstract

The field experiment was carried out at the Department of Medicinal and Aromatic Plants, K.R.C. College of Horticulture, Arabhavi, with 27 treatments of different combinations of organic and chemical fertilizers in ashwagandha. Among different combinations application of 2 tonnes of FYM + 0.5 tonne of vermicompost + 20:30:20 kg NPK per hectare recorded significantly highest plant height (70.81 cm), number of leaves (96.51), number of branches (8.89). The maximum fresh and dry root yield (13.68 q/ha and 11.09 q/ha respectively), and maximum benefit cost ratio (4.83) were also recorded in the same treatment.

Key wards : Ashwagandha, growth, dry root yield, FYM, vermicompost, NPK, B : C ratio.

Introduction

Ashwagandha (*Withania somnifera* Dunal.) belongs to the family solanaceae having chromosome number 2n = 48. It is one of the commercial medicinal crops under rainfed condition. The dried roots are rich source of 'withanine' and 'somniferine', which are mainly used in Ayurvedic and Unani preparations (Farooqi and Sreeramu, 2001). It is also well known in the traditional system of medicines of several countries for its sedative, hypnotic and antiseptic properties (Gupta, 1967) and occasionally the leaves and seeds are also used for medicinal purpose. It is cultivated over an area of 10,780 ha with a production of 8429 tonnes in India. While the annual demand increased from 7028 tonnes (2001-02) to 9127 tonnes (2004-05) necessitating the increase in its cultivation and higher production (Tripathi *et al*., 1996).

The concept of integrated nutrient management (INM) aims at the maintenance or adjustment of soil fertility and plant nutrient supply to an optimum level for sustaining the desirable crop productivity through maximization of benefit from all possible sources of plant nutrients in an integrated manner. So proper blending of chemical fertilizers with organic manures will not only improve soil health, but also to maximize the crop productivity. The balanced nutrition is an important factor for obtaining higher yield in all the crops. There is lack of information on integrated nutrient management in ashwagandha. Therefore, present investigation was under taken on integrated nutrient management in ashwagandha under rainfed conditions of northern dry zone of Karnataka.

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Materials and Methods

A field experiment was conducted at Department of Medicinal and Aromatic Plants in Kittur Rani Chennamma College of Horticulture, Arabhavi (Karnataka), India, during *Kharif* 2009-10 on sandy loam soil with pH 8.46, low in the available nitrogen (252.14 kg/ha), medium in the available phosphorus (28.63 kg/ha) and high in the available potassium (365.27 kg/ha). The experiment was laid out in Factorial randomized block design (FRBD) with three replications and there were 27 treatments consisting of 3 levels. The three levels of FYM, *viz*., F_0, F_1 & F_2 (0, 1 & 2 t/ha), vermicompost *viz*., V_0, V_1 & V_2 (0, 0.25 & 0.50 t/ha) and chemical fertilizers, *viz*., F_0, F_1 & F_2 (0:0:0, 10:15:10, 20:30:20 Kg NPK/ha). Full dose of FYM (farm yard manure) applied one week before sowing and mixed well, vermicompost and phosphorus in the form of single super phosphate (P_2O_5) and potash in the form of muriate of Potash (K_2O)

Table 1 : Effect of organic and inorganic fertilizers on plant height, number of leaves and number of branches at harvest in ashwagandha.

Treatment		Plant height (cm)				Number of leaves				Number of branches			
		F_0	F_1	F_2	Mean	F_0	F_1	F_2	Mean	F_0	F_1	F_2	Mean
M_0	V_0	39.87	60.27	63.15	54.43	17.39	34.93	37.87	30.07	4.66	6.87	7.12	6.22
	V_1	58.99	60.85	64.54	61.46	32.98	35.59	37.79	35.46	6.62	6.89	7.15	6.88
	V_2	60.12	62.69	65.17	62.66	35.86	36.80	37.88	36.85	6.71	6.92	7.21	6.94
	Mean	52.99	61.27	64.28	59.51	28.74	35.78	37.85	34.12	6.00	6.89	7.16	6.68
M_1	V_0	59.61	61.78	65.13	62.17	34.78	35.96	39.14	36.63	6.79	6.97	7.25	7.00
	V_1	60.46	62.13	65.74	62.78	35.34	38.14	41.78	38.42	6.87	7.01	7.34	7.07
	V_2	61.19	62.90	66.26	63.45	36.39	39.53	42.93	39.62	6.88	7.06	7.41	7.12
	Mean	60.42	62.27	65.71	62.80	35.50	37.88	41.28	38.22	6.85	7.01	7.33	7.06
M_2	V_0	62.78	64.43	68.08	65.10	38.10	39.33	41.73	39.72	6.94	7.23	7.89	7.35
	V_1	64.01	64.95	68.84	65.93	38.15	43.64	44.32	42.04	7.09	7.28	8.04	7.47
	V_2	65.37	67.53	70.81	67.90	38.17	43.48	45.09	42.25	7.19	7.36	8.89	7.81
	Mean	64.05	65.64	69.24	66.31	38.14	42.15	43.71	41.34	7.07	7.29	8.27	7.55
Mean of Fertilizer (F)		59.16	63.06	66.41	62.88	34.13	38.60	40.95	37.89	6.64	7.06	7.59	7.10
Mean of vermicompost (V)	V_0	54.09	62.16	65.45	60.57	30.09	36.74	39.58	35.47	6.13	7.02	7.42	6.86
	V_1	61.15	62.64	66.37	63.39	35.49	39.13	41.30	38.64	6.86	7.06	7.51	7.14
	V_2	62.23	64.37	67.41	64.67	36.81	39.94	41.97	39.57	6.93	7.11	7.84	7.29

For comparing means of	S.Em±	C.D @ 5%	S.Em±	C.D @ 5%	S.Em±	C.D @ 5%
FYM (M)	0.76	2.15	0.46	1.31	0.09	0.25
Vermicompost (V)	0.76	2.15	0.46	1.31	0.09	0.25
Fertilizer (F)	0.76	2.15	0.46	1.31	0.09	0.25
M × V	1.32	3.73	0.80	NS	0.15	NS
M × F	1.32	3.73	0.80	2.26	0.15	0.43
V × F	1.32	NS	0.80	NS	0.15	NS
M × V × F	2.28	6.46	1.38	3.92	0.26	0.74

Farm yard manure (M)
M_0= 0 t/ha
M_1= 1.0 t/ha
M_2= 2.0 t/ha

Vermicompost (V)
V_0= 0 t/ha
V_1= 0.25 t/ha
V_2= 0.50 t/ha

Fertilizer (F)
F_0= 0:0:0 NPK (kg/ha)
F_1= 10:15:10 NPK (kg/ha)
F_2= 20:30:20 NPK (kg/ha)

NS= Non significant.

and 50 per cent nitrogen in the form of urea (N) as per the treatments were applied at five to 7 cm depth in the lines just before sowing of seeds and remaining 50 per cent of nitrogen was top dressed at 35 days after sowing (DAS).

Healthy seeds of variety Jawahar Asgandh-20 were used for sowing. Before sowing, the seeds were treated with Captan at three grams per kilogram of seeds. The crop was line sown at a depth of 1-2 cm using 5 kilogram seeds per hectare with row to row spacing of 30 cm and intra-row spacing of 10 cm. Light irrigation was provided immediately after sowing. The observations were recorded at harvest (150 DAS) on five randomly selected plants from three replications. While harvesting the whole plants were uprooted manually and the roots were separated by cutting at crown region and were cleaned and kept for drying.

Results and Discussion

Growth and yield attributing characters increased with increasing level of FYM. However, significantly highest growth and yield parameters were recorded with the application of FYM (2t/ha). Similar effects were observed

Table 2 : Effect of organic and inorganic fertilizers on fresh and dry root yield in ashwagandha.

Treatment		Fresh weight of root (q/ha)				Dry weight of root (q/ha)			
		F_0	F_1	F_2	Mean	F_0	F_1	F_2	Mean
M_0	V_0	4.83	7.54	9.55	7.30	3.25	5.76	7.07	5.36
	V_1	7.11	8.16	10.06	8.44	5.61	6.16	7.26	6.34
	V_2	8.13	9.20	11.65	9.66	6.07	6.70	8.35	7.04
	Mean	6.69	8.30	10.42	8.47	4.98	6.21	7.56	6.25
M_1	V_0	7.68	8.81	11.08	9.19	5.97	6.38	7.88	6.74
	V_1	8.19	9.91	12.05	10.05	6.19	6.88	8.74	7.27
	V_2	9.40	10.68	12.66	10.91	6.62	7.70	9.12	7.81
	Mean	8.43	9.80	11.93	10.05	6.26	6.99	8.58	7.28
M_2	V_0	8.76	10.22	12.99	10.66	6.88	7.79	9.23	7.97
	V_1	9.59	11.05	13.23	11.29	7.10	8.31	10.55	8.66
	V_2	9.87	12.93	13.68	12.16	7.95	9.74	11.09	9.59
	Mean	9.41	11.40	13.30	11.37	7.31	8.62	10.29	8.74
Mean of Fertilizer (F)		8.17	9.83	11.88	9.96	6.18	7.27	8.81	7.42
Mean of vermicompost (V)	V_0	7.09	8.86	11.21	9.05	5.37	6.65	8.06	6.69
	V_1	8.30	9.70	11.78	9.93	6.30	7.12	8.85	7.42
	V_2	9.13	10.93	12.66	10.91	6.88	8.05	9.52	8.15

For comparing means of	S.Em±	C.D @ 5%	S.Em±	C.D @ 5%
FYM (M)	0.07	0.21	0.06	0.16
Vermicompost (V)	0.07	0.21	0.06	0.16
Fertilizer (F)	0.07	0.21	0.06	0.16
M × V	0.13	0.37	0.10	0.27
M × F	0.13	NS	0.10	0.27
V × F	0.13	0.37	0.10	NS
M × V × F	0.22	0.63	0.17	0.47

Farm yard manure (M)
M_0= 0 t/ha
M_1= 1.0 t/ha
M_2= 2.0 t/ha

Vermicompost (V)
V_0= 0 t/ha
V_1= 0.25 t/ha
V_2= 0.50 t/ha

Fertilizer (F)
F_0= 0:0:0 NPK (kg/ha)
F_1= 10:15:10 NPK (kg/ha)
F_2= 20:30:20 NPK (kg/ha)

NS = Non significant.

with the application of vermicompost (0.5 t/ha) and application of NPK (20:30:20 kg NPK/ha).

The results of the experiment on use of organic and chemical fertilizers showed that significant effect on growth parameters (table 1). Among different nutrients treatment $M_2V_2F_2$ (2 t FYM/ha + 0.5 t VC/ha + 20:30:20 kg NPK/ha) showed significantly maximum plant height (70.81 cm), number of leaves (45.09), number of branches per plant (8.89), which was followed by $M_2V_1F_2$ (2 t FYM/ha + 0.25 t VC/ha + 20:30:20 kg NPK/ha) and $M_2V_0F_1$ (2 t FYM/ha + 0 t VC/ha + 20:30:20 kg NPK/ha). This might be due to fact that nutrient released from both organics and inorganic fertilizers would have resulted in the increased nutrient availability, ascribed to improvement in soil health and supplied both macro and micro nutrients, which inturn enhanced the translocation of photosynthates and improved vegetative growth attributes. The similar finding had been reported by Nadukeri (2006) in coleus, Joy *et al*. (2005) in black musli.

The combined application of M × V × F had significant effect on fresh and dry root yield (table 2). Significantly maximum fresh and dry root yield (13.68 q/ha and 11.09 q/ha, respectively) were recorded in $M_2V_2F_2$ (2 t FYM/ha + 0.5 t VC/ha + 20:30:20 kg NPK/ha) followed by $M_2V_1F_2$ (2 t FYM/ha + 0.25 t VC/ha + 20:30:20 kg NPK/ha) and $M_2V_0F_1$ (2 t FYM/ha + 0 t VC/ha + 20:30:20 kg NPK/ha). This increase in yield parameters might be due to fact that FYM, vermicompost

Table 3 : Economics on use of organic manures and inorganic fertilizers in production of ashwagandha.

Treatments	Cost of cultivation (Rs/ha)	Cost of fertilizer (Rs/ha)	Cost of organics (Rs/ha)		Total cost of cultivation (Rs/ha)	Yield		Gross returns (Rs/ha)	Net returns (Rs/ha)	Benefit : cost ratio
			FYM	Vermicompost		Dry root yield (q/ha)	Seed yield (kg/ha)			
$M_0V_0F_0$	11400.00	-	-	-	11400.00	3.25	49.52	21976.11	10576.11	1.93
$M_0V_0F_1$	11400.00	677.97	-	-	12077.97	5.76	66.04	37861.98	25784.01	3.13
$M_0V_0F_2$	11400.00	1355.94	-	-	12755.94	7.07	74.82	46160.88	33404.94	3.62
$M_0V_1F_0$	11400.00	-	-	625.00	12025.00	5.61	53.96	36357.91	24332.91	3.02
$M_0V_1F_1$	11400.00	677.97	-	625.00	12702.97	6.16	69.13	40416.69	27713.72	3.18
$M_0V_1F_2$	11400.00	1355.94	-	625.00	13380.94	7.26	81.74	47646.98	34266.04	3.56
$M_0V_2F_0$	11400.00	-	-	1250.00	12650.00	6.07	60.62	39450.96	26800.96	3.12
$M_0V_2F_1$	11400.00	677.97	-	1250.00	13327.97	6.70	75.68	43984.00	30656.03	3.30
$M_0V_2F_2$	11400.00	1355.94	-	1250.00	14005.94	8.35	97.90	54995.17	40989.23	3.93
$M_1V_0F_0$	11400.00	-	500.00	-	11900.00	5.97	54.92	38566.15	26666.15	3.24
$M_1V_0F_1$	11400.00	677.97	500.00	-	12577.97	6.38	71.62	41861.17	29283.20	3.33
$M_1V_0F_2$	11400.00	1355.94	500.00	-	13255.94	7.88	79.34	51246.94	37991.00	3.87
$M_1V_1F_0$	11400.00	-	500.00	625.00	12525.00	6.19	63.65	40322.35	27797.35	3.22
$M_1V_1F_1$	11400.00	677.97	500.00	625.00	13202.97	6.88	79.81	45270.33	32067.36	3.43
$M_1V_1F_2$	11400.00	1355.94	500.00	625.00	13880.94	8.74	85.76	56727.90	42846.96	4.09
$M_1V_2F_0$	11400.00	-	500.00	1250.00	13150.00	6.62	72.31	43335.27	30185.27	3.30
$M_1V_2F_1$	11400.00	677.97	500.00	1250.00	13827.97	7.70	87.58	50579.00	36751.03	3.66
$M_1V_2F_2$	11400.00	1355.94	500.00	1250.00	14505.94	9.12	98.16	59628.12	45122.18	4.11
$M_2V_0F_0$	11400.00	-	1000.00	-	12400.00	6.88	61.11	44335.46	31935.46	3.58
$M_2V_0F_1$	11400.00	677.97	1000.00	-	13077.97	7.79	81.49	50814.33	37736.36	3.89
$M_2V_0F_2$	11400.00	1355.94	1000.00	-	13755.94	9.23	88.17	59788.5	46032.56	4.35
$M_2V_1F_0$	11400.00	-	1000.00	625.00	13025.00	7.10	73.61	46280.46	33255.46	3.55
$M_2V_1F_1$	11400.00	677.97	1000.00	625.00	13702.97	8.31	89.62	54340.83	40637.86	3.97
$M_2V_1F_2$	11400.00	1355.94	1000.00	625.00	14380.94	10.55	103.47	68473.61	54092.67	4.76
$M_2V_2F_0$	11400.00	-	1000.00	1250.00	13650.00	7.95	84.40	51919.93	38269.93	3.80
$M_2V_2F_1$	11400.00	677.97	1000.00	1250.00	14327.97	9.74	107.24	63802.00	49474.03	4.45
$M_2V_2F_2$	11400.00	1355.94	1000.00	1250.00	15005.94	11.09	118.56	72467.93	57461.99	4.83

in combination with chemical fertilizers had increased the uptake of major nutrients in the presence of humus forming microbes and growth inducing substances. These results are in the line with the findings of Arul (2002) in ashwagandha.

The maximum net returns of Rs. 57461.99 per hectare and benefit cost ratio (4.83) were obtained in $M_2V_2F_2$ (2 t FYM + 0.5 t vermicompost + 20:30:20 kg NPK/ha) followed by $M_2V_1F_2$ (Rs. 54092.67/ha) and $M_2V_2F_1$ (Rs. 53395.11/ha) compared to other treatment combinations (table 3).

Thus, it can be concluded that ashwagandha supplied with 2 t FYM + 0.5 t vermicompost + 20: 30: 20 kg NPK per hectare to recorded maximum growth, root yield and net returns under rainfed condition of northern dry zone of Karnataka.

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