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Effect of Inorganic and Organic Sources of Nutrients on N Concentration and Uptake by Ashwagandha (*Withania Somnifera* L.)

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ABSTRACT

The field experiments were conducted during *rabi* 2007-08 (I year) and *kharif* 2008 (II year) at college farm, college of agriculture, ANGRAU, Hyderabad to study the effect of INM and *panchakavya* and bio-fertilizers on N concentration and uptake. The highest N concentration, uptake and dry root yield was observed in combination of 150% NPK along with castor cake @ 2.5 t ha^{-1} + bio-fertilizers at flowering and harvest in both the years.

Key words : Ashwagandha, Castor cake,Vermi-Compost, *Panchakavya* and N uptake.

Fertilizer use is considered as a corner stone in any drive for increasing the crop yield. But the continuous use of high analysis NPK fertilizers with diminishing use of organic manures and bio-fertilizers has resulted in the depleting the nutrients from soil reserves. Integration of organics with inorganics has been found to be quite promising not only in maintaining higher productivity but also in providing greater stability in crop production. Nitrogen is key nutrient element limiting the yield of crop. An optimum N fertilizer application strategy is necessary for increasing the N use efficiency. To optimize N application a quantitative understanding of N uptake and distribution with in the plant and the impact of plant N content on crop growth and yield is essential. Keeping in this view the study was planned to know the effect of organic and inorganic sources of nutrients, *panchakavya* and bio-fertilizers on nutrient uptake and yield of Ashwagandha.

MATERIAL AND METHODS

The field experiments were conducted to study the effect of different organic manures, *panchakavya* and bio-fertilizers in combination with different levels of NPK at College farm, College of Agriculture, Rajendranagar, Hyderabad during *rabi* 2007-08 and *kharif* 2008. The experimental site during both the years was a sandy clay loam in texture, slightly alkaline in reaction (7.60 and 7.54) and non-saline (0.16 and 0.18 dS m^{-1}) in nature. It was low in organic carbon (0.40 and 0.40%) and low in available nitrogen (203 and 200 kg ha^{-1}) and phosphorous (17.08 and 17.12 kg ha^{-1}) and high in available potassium (287 and 263 kg ha^{-1}). The field experiment was laid out with split plot design having four main treatments M_1 - Control (no fertilizers), M_2 - 50% NPK (30-25-20 Kg ha^{-1}), M_3 - 100% NPK (60-50-40 Kg ha^{-1}) and M_4 - 150% NPK (90-75-60 Kg ha^{-1})) and four sub treatments S_1 - No manures + Bio-Fertilizers (BF) (*Azospirillum* +PSB*),* S_2 - Castor cake @ 2.5 t ha^{-1} +BF, S_3 - Vermi-compost @ 1 t ha^{-1} +BF and S_4 - *Panchakavya* @ 5% foliar spray at 30, 60 and 90 DAS + BF. The recommended N, P and K were applied as per the treatments through urea, single super phosphate and muriate of potash, respectively. Nitrogen was applied in three equal splits at basal, 30 DAS and at flowering stage through urea. Entire recommended phosphorous was applied at basal through single super phosphate. Potassium was applied in two equal splits at basal and at flowering stage through muriate of potash. Bio-fertilizers were applied by mixing each 2 kg of *Azospirillum* and PSB (Phosphorous Solubilising Bacteria) in 50 Kg FYM ha^{-1} and applied in two splits at basal and at 30 DAS in crop rows. Organic manures like castor cake and vermicompost were applied as a basal dose as per the treatments. *Panchakavya* made from cow products were sprayed as per treatments at different days after sowing in different concentrations. *Panchakavya* is an organic product prepared by mixing five products obtained from cow *viz.,* cow dung (5 Kg), cow urine (3

litres), cow milk (2 litres), cow curd (2 litres) and cow ghee (1 litre). In addition to the above products, sugarcane juice (3 litres), tender coconut water (3 litres) and riped banana (1 Kg) was also added to get 20 litres of *panchakavya* stock solution. The mixture is placed in a wide mouthed mud pot and kept under shade. The contents were stirred twice a day for about 20 minutes, both in the morning and in the evening to facilitate aerobic microbial activity. About 10 days after fermentation, it was used for spraying (Natarajan, 2003). The crop was harvested at 203 and 175 days after sowing during *rabi* 2007-2008 and *Kharif* 2008, respectively. The dry root yield, N concentration and uptake by shoot and root and total uptake was estimated at flowering and harvest in both the years.

RESULTS AND DISCUSSION

Nitrogen concentration

The data on N concentration of Ashwagandha shoot and root at flowering and harvest during *rabi* 2007 - 2008 and *kharif* 2008 were furnished in the table 1 In general the N content in shoots in *rabi* 2007-08 was higher than roots both at flowering (0.420 to 0.610%) and at harvest (0.226 to 0.406%). Compared to the flowering stage, at harvest stage the N content in shoots was found to be decreased (0.067 to 0.223%) where as in roots it slightly increased (0.004 to 0.075%). Different levels of fertilizers, organic manures, *panchakavya* and BF as well as their interaction exerted significant influence on N concentration of shoot and root at flowering and harvest of Ashwagandha. Similar to the first year, in *kharif* 2008 also the N content in roots was relatively lesser than shoots both at flowering (0.426 to 0.485%) and harvest (0.117 to 0.207%). Compared to flowering at harvest the N content in shoots was decreased relatively (0.230 to 0.268%) and where as the same increased in roots (0.048 to 0.060%).

In both the shoot and roots during both the years at flowering and harvest, among fertilizer levels, the maximum N concentration was obtained from 150% NPK, which was significantly superior to all other fertilizer levels tried, followed by 100% NPK and 50% NPK while the lowest concentration of N was noticed with no fertilizers. Among the organic manures, *panchakavya* and BF, castor cake @ 2.5 t ha^{-1} + BF resulted the highest concentration of N followed by vermi-compost @ 1 t ha^{-1} + BF and *panchakavya* @ 5% foliar spray with BF. However, the lowest was recorded with no manures.

Combined application of 150% NPK along with castor cake @ 2.5 t ha^{-1} + BF recorded significantly highest N concentration (M_4S_2) followed by 150% NPK along with vermi-compost @ 1 t ha^{-1} + BF (M_4S_3) which was on par with the treatments 100% NPK with castor cake @ 2.5 t ha^{-1} + BF (M_3S_2). The lowest N concentration was noticed with control + BF (M_1S_1). It is interesting to note that application of castor cake @ 2.5 t ha^{-1} + BF (M_1S_2) and vermi-compost @ 1 t ha^{-1} + BF (M_1S_3) recorded higher N concentration than 50% NPK alone (M_2S_1) and 100% NPK alone (M_3S_1). The N content in roots followed the same trend as indicated under shoots.

Nitrogen uptake

The data pertaining to N uptake by shoot, roots and total uptake at both flowering and harvest stages of Ashwagandha during *rabi* 2007 – 2008 and *kharif* 2008 are presented in tables 2 and 3. The N uptake by shoot, root and total uptake was significantly influenced by different levels of fertilizers, organic manures, *panchakavya* and BF as well as with their interaction at flowering and harvest.

The N uptake by shoot, root and total N uptake was gradually increased with increase in fertilizer levels from 0% NPK to 150% NPK at flowering and harvest. Application of 150% NPK recorded significantly the highest N uptake followed by 100% NPK and 50% NPK and the lowest was noticed with no fertilizers. Among organic manures, *panchakavya* and BF, the castor cake + BF showed the highest N uptake followed by vermi-compost + BF and *panchakavya* + BF. The lowest was observed under no manures. The castor cake + BF recorded 25.21, 52.52 & 96.49% and 25.58, 51.24 & 86.89% increase over vermi-compost+ BF, *panchakavya* + BF and no manures, respectively at flowering in *rabi* 2007-08 and *kharif* 2008. Integrated use of 150% NPK with castor cake+ BF recorded significantly the highest N uptake (M_4S_2) followed by 150% NPK with vermi-compost+ BF (M_4S_3). The lowest N uptake was noticed with control (M_1S_1).

Table 1. Effect of inorganic fertilisers, organic manures, panchakavya and bio fertilisers on N concentration (%) in shoot and root of Ashwagandha.

Treatments	N concentration in Shoot					N concentration in root				
	Rabi 2007-08, Flowering									
Main / Sub	S_1 No manures	S_2 castor cake @ 2.5 t ha^{-1} + BF*	S_3 vermi-compost @ 1 t ha^{-1} + BF	S_4 panchakavya @ 5% foliar spray + BF	Mean	S_1 No manures	S_2 castor cake @ 2.5 t ha^{-1} + BF*	S_3 vermi-compost @ 1 t ha^{-1} + BF	S_4 panchakavya @ 5% foliar spray + BF	Mean
M_1-0% NPK	1.480	1.653	1.620	1.520	1.568	0.995	1.306	1.153	1.139	1.148
M_2-50% NPK	1.533	1.810	1.704	1.583	1.657	1.020	1.343	1.206	1.171	1.185
M_3-100% NPK**	1.547	1.946	1.880	1.667	1.760	1.157	1.378	1.319	1.215	1.267
M_4-150% NPK	1.720	2.100	1.983	1.863	1.916	1.187	1.432	1.374	1.231	1.306
Mean	1.570	1.877	1.796	1.658		1.099	1.364	1.263	1.187	
				SE(M)	C.D				SE(M)	C.D
Main				0.019	0.038				0.005	0/011
Sub				0.013	0.027				0.004	0.008
Main at same or different levels of sub				0.036	0.071				0.010	0.021
	Rabi 2007-08, Harvest									
M_1-0% NPK	1.393	1.540	1.450	1.413	1.449	1.074	1.345	1.279	1.195	1.223
M_2-50% NPK	1.473	1.653	1.550	1.480	1.539	1.105	1.406	1.261	1.233	1.251
M_3-100% NPK**	1.520	1.840	1.623	1.560	1.636	1.150	1.428	1.279	1.226	1.271
M_4-150% NPK	1.560	1.900	1.693	1.620	1.693	1.164	1.443	1.297	1.245	1.287
Mean	1.487	1.733	1.579	1.518		1.123	1.405	1.275	1.225	
				SE(M)	C.D				SE(M)	C.D
Main				0.017	0.033				0.007	0.013
Sub				0.016	0.032				0.012	0.024
Main at same or different levels of sub				0.034	0.066				0.017	0.034
	Rabi 2008, Flowering									
M_1-0% NPK	1.440	1.620	1.577	1.490	1.532	1.048	1.177	1.113	1.087	1.106
M_2-50% NPK	1.483	1.680	1.627	1.550	1.585	1.060	1.207	1.167	1.127	1.140
M_3-100% NPK**	1.550	1.767	1.693	1.603	1.653	1.110	1.247	1.230	1.167	1.189
M_4-150% NPK	1.603	1.853	1.747	1.617	1.705	1.140	1.327	1.233	1.193	1.220
Mean	1.519	1.730	1.661	1.565		1.089	1.239	1.183	1.143	
Main				0.023	0.045				0.010	0.019
Sub				0.017	0.033				0.007	0.014
Main at same or different levels of sub				0.043	N.S.				0.018	N.S.
	Rabi 2008, Harvest									
M_1-0% NPK	1.203	1.407	1.297	1.209	1.282	1.093	1.195	1.172	1.168	1.157
M_2-50% NPK	1.260	1.423	1.327	1.260	1.317	1.132	1.257	1.212	1.197	1.200
M_3-100% NPK**	1.340	1.490	1.413	1.437	1.420	1.180	1.323	1.253	1.215	1.243
M_4-150% NPK	1.393	1.580	1.500	1.427	1.475	1.201	1.378	1.265	1.229	1.268
Mean	1.302	1.475	1.384	1.333		1.152	1.288	1.226	1.202	
				SE(M)	C.D				SE(M)	C.D
Main				0.024	0.048				0.005	0.010
Sub				0.013	0.025				0.004	0.007
Main at same or different levels of sub				0.044	0.087				0.010	0.019

BF* - Bio fertilizers (Azospirillum + Phosphorous Solubilizing Bacteria) 100% NPK** = 60 - 50 - 40 kg NPK ha^{-1}

Table 2. Effect of inorganic fertilisers, organic manures, panchakavya and bio fertilisers on N uptake (kg ha-1) by Ashwagandha at flowering.

Treatments	*Rabi* 2007-08 (I year)					*Kharif* 2008 (II year)				
	N uptake by shoot					N uptake by shoot				
Main / Sub	S_1 No manures	S_2 castor cake @ 2.5 t ha^{-1} + BF*	S_3 vermi-compost @ 1 t ha^{-1} + BF	S_4 panchakavya @ 5% foliar spray + BF	Mean	S_1 No manures	S_2 castor cake @ 2.5 t ha^{-1} + BF*	S_3 vermi-compost @ 1 t ha^{-1} + BF	S_4 panchakavya @ 5% foliar spray + BF	Mean
M_1-0% NPK	16.96	26.80	24.05	20.14	21.98	14.90	23.91	21.22	17.78	19.45
M_2-50% NPK	21.61	45.60	34.17	27.64	32.25	19.09	38.58	29.70	24.60	27.99
M_3-100% NPK**	26.55	54.52	41.36	36.97	39.85	24.50	46.06	34.38	32.04	34.25
M_4-150% NPK	33.53	66.92	55.25	42.34	49.51	28.98	54.94	44.87	33.67	40.62
Mean	24.66	48.46	38.70	31.77		21.87	40.87	32.54	27.02	
				SE(M)	C.D				SE(M)	C.D
Main				0.750	2.460				0.695	1.410
Sub				0.480	1.760				0.576	1.080
Main at same or different levels of sub				1.270	3.920				1.124	2.340
	N uptake by root					N uptake by root				
M_1-0% NPK	1.011	1.471	1.305	1.168	1.239	1.053	1.285	1.232	1.217	1.197
M_2-50% NPK	1.077	1.655	1.357	1.249	1.335	1.147	1.456	1.342	1.275	1.305
M_3-100% NPK**	1.174	1.803	1.476	1.295	1.437	1.248	1.618	1.464	1.373	1.426
M_4-150% NPK	1.226	1.842	1.510	1.389	1.492	1.296	1.725	1.514	1.424	1.490
Mean	1.122	1.693	1.412	1.275		1.186	1.521	1.388	1.322	
				SE(M)	C.D				SE(M)	C.D
Main				0.036	0.050				0.027	0.054
Sub				0.051	0.091				0.033	0.066
Main at same or different levels of sub				0.081	0.132				0.060	0.117
	Total N uptake					Total N uptake				
M_1-0% NPK	17.97	28.27	25.36	21.31	23.23	15.95	25.19	22.45	19.00	20.65
M_2-50% NPK	22.69	47.26	35.53	28.89	33.59	20.24	40.03	31.04	25.87	29.30
M_3-100% NPK**	27.72	56.32	42.84	38.27	41.29	25.75	47.68	35.85	33.41	35.67
M_4-150% NPK	34.76	68.76	56.76	43.73	51.00	30.28	56.67	46.39	35.10	42.11
Mean	25.78	50.15	40.12	33.05		23.05	42.39	33.93	28.35	
				SE(M)	C.D				SE(M)	C.D
Main				0.78	2.60				0.662	1.526
Sub				0.60	2.32				0.624	1.386
Main at same or different levels of sub				1.38	4.42				1.280	2.982

BF* - Bio fertilizers (Azospirillum + Phosphorous Solubilizing Bacteria) 100% NPK** = 60 - 50 - 40 kg NPK ha^{-1}

N uptake by shoot

At flowering, application of 150% NPK recorded 24.24 & 53.52% and 18.60 & 45.10% increase in N uptake over 100% NPK and 50% NPK respectively. However it was showed 1.25 and 1.08 times more than no fertilizers in both the years, respectively. At harvest, during *rabi* 2007-08 and *kharif* 2008, application of 150% NPK recorded 18.74 & 48.13% and 19.40 & 49.40% increase in N uptake over 100% NPK and 50% NPK, respectively. However it was 1.18 and 1.15 times more than no fertilizers. The castor cake + BF showed 32.49, 56.54 & 93.93% and 28.19, 50.47 & 87.62% increase over vermi-compost+ BF, *panchakavya*+ BF and no manures, respectively.

Root N uptake

At flowering application of 150% NPK gave 3.78, 11.80 & 20.44% higher N uptake in *rabi* 2007-08 and 4.51%, 14.18% and 24.50% during kharif 2008 over 100% NPK, 50% NPK and no fertilizers, respectively. In both the years, application

Table 3. Effect of inorganic fertilisers, organic manures, panchakavya and bio fertilisers on N uptake (kg ha-1) by Ashwagandha at harvest.

Treatments	*Rabi* 2007-08 (I year)					*Kharif* 2008 (II year)				
	N uptake by shoot					N uptake by shoot				
Main / Sub	S_1 No manures	S_2 castor cake @ 2.5 t ha^{-1} + BF*	S_3 vermi-compost @ 1 t ha^{-1} + BF	S_4 panchakavya @ 5% foliar spray + BF	Mean	S_1 No manures	S_2 castor cake @ 2.5 t ha^{-1} + BF*	S_3 vermi-compost @ 1 t ha^{-1} + BF	S_4 panchakavya @ 5% foliar spray + BF	Mean
M_1-0% NPK	28.70	45.53	39.09	33.82	36.79	19.96	33.77	28.13	22.90	26.19
M_2-50% NPK	37.64	76.40	56.75	45.50	54.07	25.89	53.40	39.26	32.26	37.70
M_3-100% NPK**	47.28	94.61	65.03	62.91	67.46	33.81	62.36	45.97	46.55	47.17
M_4-150% NPK	55.41	111.27	86.54	67.18	80.10	40.20	75.32	62.03	47.72	56.32
Mean	42.26	81.95	61.85	52.35		29.96	56.21	43.85	37.36	
				SE(M)	C.D				SE(M)	C.D
Main				0.420	1.470				0.735	2.530
Sub				0.470	1.390				0.478	1.390
Main at same or different levels of sub				0.920	2.800				1.107	3.490
	N uptake by root					N uptake by root				
M_1-0% NPK	2.568	3.896	3.225	3.042	3.183	2.677	3.356	3.111	3.006	3.038
M_2-50% NPK	2.711	4.267	3.551	3.248	3.444	2.852	3.713	3.435	3.190	3.297
M_3-100% NPK**	3.229	4.662	4.160	3.533	3.896	3.117	4.048	3.828	3.500	3.623
M_4-150% NPK	3.355	4.983	4.366	3.756	4.115	3.268	4.414	3.880	3.672	3.808
Mean	2.966	4.452	3.826	3.395		2.978	3.883	3.564	3.342	
				SE(M)	C.D				SE(M)	C.D
Main				0.038	0.075				0.036	0.071
Sub				0.036	0.070				0.035	0.068
Main at same or different levels of sub				0.075	0.146				0.072	0.140
	Total N uptake					Total N uptake				
M_1-0% NPK	31.27	49.43	42.31	36.86	39.97	22.63	37.13	31.24	25.91	29.23
M_2-50% NPK	40.35	80.67	60.30	48.75	57.52	28.74	57.11	42.7	35.45	41.00
M_3-100% NPK**	50.51	99.28	69.19	66.45	71.36	36.93	66.41	49.8	50.05	51.49
M_4-150% NPK	58.77	116.25	90.90	70.93	84.21	43.47	79.74	65.91	51.40	60.92
Mean	45.22	86.41	65.68	55.75		32.94	60.10	47.41	40.70	
				SE(M)	C.D				SE(M)	C.D
Main				0.813	2.452				1.061	2.144
Sub				0.912	2.750				0.674	1.363
Main at same or different levels of sub				1.678	5.063				1.957	3.956

BF* - Bio fertilizers (Azospirillum + Phosphorous Solubilizing Bacteria) 100% NPK** = 60 - 50 - 40 kg NPK ha^{-1}

of castor cake+ BF showed 19.90, 32.75 & 50.89% (*rabi* 2007-08) and 9.60, 15.00 & 28.20% (*kharif* 2008) increase than vermi-compost + BF, *panchakavya* + BF and no manures, respectively. At harvest, application of 150% NPK recorded 5.62, 19.47 & 29.29% (*rabi* 2007-08) and 5.10, 15.50 & 25.40% (*kharif* 2008) increase over 100%, 50% and no fertilizers, respectively in both the years. The castor cake + BF resulted 16.38, 31.14 & 50.11% during *rabi* 2007-08 and 8.96, 16.18 & 30.38% in *kharif* 2008 increase in N uptake over vermi-compost+ BF, *panchakavya* + BF and no manures, respectively.

Total N uptake

Application of 150% NPK showed 23.52 & 51.83% and 18.04 & 43.74% higher N uptake over 100% and 50% NPK, respectively. While it

Table 4. Effect of inorganic fertilisers, organic manures, panchakavya and bio fertilisers on dry root yield (kg ha-1) of Ashwagandha at harvest

Treatments	*Rabi* 2007-08					*Kharif* 2008				
Sub	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
Main	No manures	castor cake @ 2.5 t ha^{-1} + BF*	vermi-compost @ 1 t ha^{-1} + BF	panchakavya @ 5% foliar spray + BF		No manures	castor cake @ 2.5 t ha^{-1} + BF*	vermi-compost @ 1 t ha^{-1} + BF	panchakavya @ 5% foliar spray + BF	
M_1-0% NPK	248	298	280	267	273	242	285	279	277	271
M_2-50% NPK	265	320	294	277	289	269	308	294	283	289
M_3-100% NPK**	279	344	315	289	307	281	325	310	300	304
M_4-150% NPK	287	348	317	305	315	287	333	318	308	311
Mean	273	328	302	285		272	313	301	292	
				C.D	SE(M)				C.D	SE(M)
Main				5.47	2.79				3.92	2.00
Sub				5.03	2.56				4.50	2.30
Main at same or different levels of sub				10.73	5.47				8.14	4.15

BF* - Bio fertilizers (Azospirillum + Phosphorous Solubilizing Bacteria) 100% NPK** = 60 - 50 - 40 kg NPK ha^{-1}

was1.2 and 1.04 times more than no fertilizers during both the years, respectively. The castor cake+ BF noticed 25.00, 51.75 & 94.49% (*rabi* 2007-08) and 24.93, 49.50 & 83.87% (*kharif* 2008) increase in N uptake over vermi-compost+ BF, *panchakavya* + BF and no manures, respectively at flowering. Whereas at harvest in both the years, application of 150% NPK recorded 18.01 & 46.41% (*rabi* 2007-08) and 18.31 & 48.58% (*kharif* 2008) increase in N uptake over 100% NPK and 50% NPK, respectively. However it was 1.11 and 1.08 times more than no fertilizers. The castor cake + BF showed 31.57, 55.00 & 91.07% and 26.76, 47.66 & 82.44% increase over vermi-compost+ BF, *panchakavya*+ BF and no manures, respectively.

Data showed an increase in uptake of nutrients from flowering to harvest in relation to the increase in dry matter production with increase in age of the crop. Conjunctive use of inorganic fertilizers with organic manures recorded the highest N content which might be due to increasing rates of fertilization could be ascribed primarily due to increased availability of this nutrient in the crop root resulted in increased absorption of the elements by the plants. Similar results were reported by Khandelwal *et al.* (2003) in henna, Prathibha and Korwar (2005) in Indigo and Venkata Reddy *et al.* (2004) in Ashwagandha which inturn resulted in higher concentration of N, P and K in the plant biomass.

Dry root yield

The dry root yield at harvest during *rabi* 2007-08 (I year) and *kharif* 2008 (II year) were presented in Table 1. Dry root yield was increased from 273 kg ha^{-1} to 315 kg ha^{-1} and 2714 to 311 kg ha^{-1} with increased levels of application of fertilizers from 0% to 150% NPK. There was a successive increase in dry root yield observed from 0% NPK to 150% NPK. The highest dry root yield was observed in 150% NPK (315 and 311 kg ha^{-1}) which was significantly differed from any fertilizer level and the lowest was noticed with no fertilizers (273 and 271 kg ha^{-1}). The percent increase from no fertilizers to 50%, 100% and 150% NPK was 4.71, 11.23 and 14.13% in *rabi* 2007-2008 and 5.86, 11.35 and 13.91% during *kharif* 2008 respectively.

Among organic manures / *panchakavya* and BF, application of castor cake @ 2.5 t ha^{-1} + BF recorded significantly the highest dry root yield (328 and 313 kg ha^{-1}). The lowest was noticed with no manures+ BF (273 and 272 kg ha^{-1}). The castor cake @ 2.5 t ha^{-1} + BF, vermi-compost @ 1 t ha^{-1} + BF and *panchakavya* @ 5% foliar spray with BF showed 20.14, 10.62 and 4.39% in *rabi* 2007-2008 and 15.07 10.66 and 7.355% during *kharif* 2008, respectively increase over no manures.

There was significant difference observed with fertilizer levels, organic manures, *panchakavya* and BF on dry root yield. The highest dry root yield was observed with 150% NPK along

with castor cake @ 2.5 t ha^{-1} + BF (348 and 333 kg ha^{-1}) (M_4S_2) which was on par with 100% NPK + castor cake @ 2.5 t ha^{-1} + BF (344 and 325 kg ha^{-1}) (M_3S_2). The lowest was noticed with control (248 and 252 kg ha^{-1}) (M_1S_1).

Higher yields with 150% NPK might be due to high nitrogen, phosphorus and potassium supply leads to increased number of branches, leaves and leaf area which have helped in the efficient synthesis and translocation of photosynthates from the source to sink (Nigam *et al*., 1984; Praveen, 2000). The C:N ratio of castor cake is lower indicates rapid mineralisation of nitrogen from castor cake. The higher yield due to integration of inorganic fertilizers and organic manures could be due to the higher yield attributing characters like root length and girth, higher dry matter production, higher supply of nutrients, favourable physical and biological environment in the soil leading to better root activity and nutrient absorption (Chauhan *et al*., 2005; Joy *et al*.,2005; Mazumdar *et al*., 2002). As Ashwagandha is a root crop, improvement of soil physical environment might be helped in better development of roots. The increase in yield due to inoculation of bio fertilizers could be attributed to the factors like N contribution either by inoculated strain, the positive effect of inoculation in contribution with organic matter and increased P uptake due to solubilization effect of phosphate solubilizing bacteria (Rao 1998).

It is concluded that, the N concentration in shoot was decreased from flowering to harvest, whereas in root, the nutrient concentration increased from flowering to harvest. In general with increase in NPK levels there was increase in N concentration. The N uptake was increase from flowering to harvest, in relation to the increase in dry matter production with increase in age of crop. Among all the treatments, combined application of 150% NPK + castor cake @ 2.5 t ha^{-1} with BF recorded maximum N concentration, uptake and highest dry root yield.

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