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Effect of integrated nutrient management on kalmegh (*Andrographis Paniculata*)

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Abstract

Data revealed pooled mean of plant height and No. of Branches per plant was significantly influenced by various treatments of manures and fertilizers. Significantly higher plant height was recorded at Vermicompost @ 7.5 t ha⁻¹ followed by FYM 15 t ha⁻¹ organic manure treatment. Similarly significantly higher numbers of branches were noticed with Vermicompost @ 7.5 t ha⁻¹ followed by FYM 15 t ha⁻¹ in organic manure treatment. At same time application of chemical fertilizer with 80:30:50 Kg/ha NPK (Half N with full P & K as basal and remaining half N in three equal splits at 25, 40 & 60 DAS) (T₇) recoded significantly higher plant height (62.07 cm) and No. of branches (33.85). From the pooled data, it is revealed that the higher Fresh herbage and dry herbage yield and highest GMR was observed significantly highest with application of with Vermicompost @ 5 t/ha which is at par with application of with Vermicompost @ 7.5 t/ha (M₅), and application of castor cake 2.5 t/ha. Herbage yield, GMR, was significantly highest with application of (T₆) 80:30:50 Kg/ha NPK (Half N with full P & K as basal).

Keywords: kalmegh, organic manure, npk, gmr, b: c ratio

Introduction

The use of plants and plant products as medicines could be traced as far back as the beginning of human civilization (1). They are considered as the backbone of traditional medicine and are widely used to treat a plethora of acute and chronic diseases ranging from the common cold to complex human diseases all over the world (2). *Andrographis paniculata*, known on the Indian subcontinent as Chirayetah and Kalmegh in Urdu and Hindi languages, respectively, is an annual plant, 1-3 ft high, that is one of the most commonly used plants in the traditional systems of Unani and Ayurvedic medicines. It is called Creat in English and is known as the "king of bitters." It grows in hedge rows throughout the plains of India and is also cultivated in gardens. It also grows in many other Asian countries India is one of the world's twelve leading biodiversity centers with the presence of over 45,000 different plant species. *Andrographis paniculata*, a traditional medicinal plant, has been used for centuries to successfully treat respiratory diseases, skin infections, herpes, dysentery, fever, sore throat, lower urinary tract infections, to reduce inflammation and to stop diarrhea. It is used in Malaysian folk medicine for diabetes and hypertension. It is also known to have antibacterial, immunomodulating, antivenomous and antithrombotic properties. Beyond this pharmaceutical approach to plants, there is a wide tendency to utilize herbal products to supplement the diet, mainly with the intention of improving the quality of life and preventing the diseases of elderly people. India has been identified as a major resourceful area in the traditional and alternative medicines globally. Now a days, there is revival of interest with herbal-based medicine due to the increasing realization of the health hazards associated with the indiscriminate use of modern medicine and the herbal drug industries is now very fast growing sector in the international market (3). There is great demand for herbal medicine in the developed as well as developing countries like India, because of their wide biological activities, higher safety of margin than the synthetic drugs and lesser costs (4).

Material and Method

The experiment was conducted at Nagarjun Medicinal Plant Garden Dr. Panjabrao Deshmukh Krishi Vidyaapeeth, Akola (MS). The experiment was laid out in split plot design with the three replication. Treatments consisted of seven organic fertilizer source were taken as main plot treatment and seven chemical fertilizer sources as sub plot treatments. The crop was subjected to recommended package of agronomic practices to obtain a healthy crop. The net plot is converted in to quintal per hectare by using hectare factor.

Treatment details

It includes sevenorganic treatments viz. **M₁**- Control, **M₂**- FYM 10 t ha⁻¹, **M₃**- FYM 15 t ha⁻¹, **M₄**- Vermicompost 5 t ha⁻¹, **M₅**- Vermicompost 7.5 t ha⁻¹, **M₆**- Castor cake 1.5 t ha⁻¹, **M₇**- Castor cake 2.5 t ha⁻¹ and seven chemical fertilizer treatments viz. **T₁**- Control, **T₂**- 40:10:30 Kg/ha NPK, **T₃**- 60:20:40 Kg/ha NPK, **T₄**- 80:30:50 Kg/ha NPK, **T₅**- 80:30:50 Kg/ha NPK (Half N with full P & K as basal and remaining half of N at 25 DAS), **T₆**- 80:30:50 Kg/ha NPK (Half N with full P & K as basal and remaining half N in two equal splits at 25 and 40 DAS), **T₇**- 80:30:50 Kg/ha NPK (Half N with full P & K as basal and remaining half N in three equal splits at 25, 40 & 60 DAS). Yield recorded during the investigation and data analyzed statically.

Result and Discussion**1. Effect of organic manures and fertilizers growth and yield of Kalmegh**

Data presented in Table -1 revealed pooled mean of plant height and No. of Branches per plant was significantly influenced by various treatments of manures and fertilizers. Significantly higher plant height was recorded at Vermicompost @ 7.5 t ha⁻¹ followed by FYM 15 t ha⁻¹ organic manure treatment. Similarly significantly higher numbers of branches were noticed with Vermicompost @ 7.5 t ha⁻¹ followed by FYM 15 t ha⁻¹ in organic manure treatment. Application of 80:30:50 Kg/ha NPK (Half N with full P & K as basal and remaining half N in three equal splits

at 25, 40 & 60 DAS) (**T₇**) recoded significantly higher plant height (62.07 cm) and No. of branches (33.85). Interaction between organic manures and fertilizers were non-significant in case of No. of branches and significant in case of plant height.

Yield contributing characters

Data pertaining to yield contributing characters is presented in Table 1-3 significant differences were recorded in pooled means of fresh weight and dry weight per plant. The significantly higher pooled means fresh weight per plant was at FYM 10 t ha⁻¹ followed by castor cake 2.5 t ha⁻¹ and Vermicompost 7.5 t ha⁻¹. Significantly higher dry weight per plant was observed with castor cake 2.5 t ha⁻¹ but it was at par with Vermicompost 7.5 t ha⁻¹. Pooled means of fresh weight and dry weight per plant were recorded significant differences due to application of chemical fertilizers. Application of 80:30:50 Kg/ha NPK (Half N with full P & K as basal and remaining half N in two equal splits at 25, 40 & 60 DAS) (**T₆**) recoded significantly highest Fresh weight per plant whereas, Dry foliage yield per plant was significantly higher in **T₇** (Half N with full P & K as basal and remaining half N in three equal splits at 25 and 40 DAS) at par with **T₆** application of 80:30:50kg ha NPK (Half N with full P & K as basal and remaining half N in two equal splits at 25 and 40 DAS). Interaction between organic manures and fertilizers were found significant in case of Fresh Weight per plant however non-significant in case of Dry Weight per plant.

Table 1: Plant Height and No. of Branches of Kalmegh as influenced by different organic and chemical fertilizers treatments

Treatments	Plant Height (cm)				No. of Branches /Plant			
	2015-16	2016-17	2017-18	Pooled Mean	2015-16	2016-17	2017-18	Pooled Mean
Main plot Treatments : Organic manures								
M1- Control	48.28	59.53	64.37	57.39	24.51	27.04	34.70	28.75
M2- FYM 10 t ha ⁻¹	51.65	61.97	63.94	59.19	26.48	35.53	34.90	32.30
M3- FYM 15 t ha ⁻¹	52.87	64.12	63.10	60.03	27.97	37.66	35.31	33.65
M4- Vermicompost 5.0 t ha ⁻¹	52.46	63.35	61.99	59.27	27.67	36.45	35.10	33.07
M5- Vermicompost 7.5 t ha ⁻¹	54.00	64.30	62.54	60.28	28.76	37.98	35.30	34.01
M6- Castor cake 1.5 t ha ⁻¹	51.04	60.91	62.88	58.28	26.33	34.71	35.47	32.17
M7- Castor cake 2.5 t ha ⁻¹	52.01	62.58	61.68	58.76	27.33	36.03	35.84	33.07
SE (m) ±	0.79	1.22	1.89	0.65	0.55	0.51	0.51	0.42
CD (P=0.05)	2.45	3.75	NS	2.00	1.68	1.57	NS	1.29
Sub plot Treatments : Chemical fertilizers								
T1- Control	47.34	55.90	64.55	55.93	23.57	30.70	36.00	30.09
T2- 40:10:30 Kg/ha NPK	48.76	59.22	62.80	56.93	24.73	33.77	34.95	31.15
T3- 60:20:40 Kg/ha NPK	50.89	61.75	61.60	58.08	26.29	35.20	34.55	32.01
T4- 80:30:50 Kg/ha NPK	50.91	63.65	62.40	58.99	27.58	36.11	34.71	32.80
T5- 80:30:50 Kg/ha NPK (Half N with full P & K as basal and remaining half of N at 25 DAS)	52.66	64.62	63.37	60.22	28.57	36.55	35.21	33.44
T6- 80:30:50 Kg/ha NPK (Half N with full P & K as basal and remaining half N in two equal splits at 25 and 40 DAS)	55.53	65.26	62.16	60.98	28.94	36.80	35.30	33.68
T7- 80:30:50 Kg/ha NPK (Half N with full P & K as basal and remaining half N in three equal splits at 25, 40 & 60 DAS)	56.20	66.39	63.61	62.07	29.38	36.28	35.89	33.85
SE (m) ±	0.45	0.68	0.79	0.33	0.39	0.48	0.54	0.27
CD (P=0.05)	1.24	1.88	2.19	0.93	1.07	1.34	NS	0.74
Interaction (A*B)								
SE (m) ±	1.18	1.80	2.09	0.33	1.02	1.28	1.43	0.27
CD (P=0.05)	NS	NS	5.80	0.93	NS	3.54	NS	NS
CV%	3.96	4.99	5.76	4.49	6.54	6.32	7.02	6.53

Table 2: Fresh weight and Dry weight g/plant of Kalmegh as influenced by different organic and chemical fertilizers treatments

Treatments	Fresh weight g/plant				Dry weight (g/plant)			
	2015-16	2016-17	2017-18	Pooled Mean	2015-16	2016-17	2017-18	Pooled Mean
Main plot Treatments : Organic manures								
M1- Control	49.45	71.79	83.10	68.18	19.57	28.75	30.86	26.39
M2- FYM 10 t ha ⁻¹	52.29	77.26	88.08	72.54	21.86	32.45	34.37	29.56
M3- FYM 15 t ha ⁻¹	53.14	83.10	72.22	69.49	22.52	34.39	30.98	29.30
M4- Vermicompost 5.0 t ha ⁻¹	52.81	80.41	77.73	70.32	22.33	33.77	33.84	29.98
M5- Vermicompost 7.5 t ha ⁻¹	54.38	85.93	73.28	71.20	22.71	34.90	30.81	29.48
M6- Castor cake 1.5 t ha ⁻¹	51.33	74.90	78.10	68.11	20.90	31.46	34.14	28.83
M7- Castor cake 2.5 t ha ⁻¹	52.62	78.10	83.30	71.28	22.05	32.80	36.58	30.48
SE (m) ±	0.57	1.35	1.61	0.741	0.54	0.57	2.00	0.616
CD (P=0.05)	1.76	4.16	4.98	2.282	1.67	1.75	6.18	1.900
Sub plot Treatments : Chemical fertilizers								
T1- Control	48.29	70.00	73.42	63.90	18.76	28.96	31.78	26.47
T2- 40:10:30 Kg/ha NPK	50.48	73.34	76.87	66.90	20.10	30.36	31.59	27.35
T3- 60:20:40 Kg/ha NPK	51.88	75.88	74.86	67.54	21.10	31.43	30.40	27.64
T4- 80:30:50 Kg/ha NPK	53.24	78.89	80.19	70.77	22.14	32.69	34.01	29.61
T5- 80:30:50 Kg/ha NPK (Half N with full P & K as basal and remaining half of N at 25 DAS)	53.62	81.72	77.25	70.86	23.00	33.88	34.14	30.34
T6- 80:30:50 Kg/ha NPK (Half N with full P & K as basal and remaining half N in two equal splits at 25 and 40 DAS)	54.10	85.23	89.31	76.21	23.24	35.35	33.10	30.56
T7- 80:30:50 Kg/ha NPK (Half N with full P & K as basal and remaining half N in three equal splits at 25, 40 & 60 DAS)	54.43	86.44	83.92	74.93	23.62	35.86	36.73	32.04
SE (m) ±	0.56	1.69	1.70	0.813	0.49	0.71	1.10	0.474
CD (P=0.05)	1.56	4.68	4.70	2.254	1.36	1.97	3.06	1.312
Interaction (A*B)								
SE (m) ±	1.49	4.47	4.48	0.813	1.30	1.88	2.92	0.474
CD (P=0.05)	NS	NS	12.43	2.254	NS	NS	8.09	NS
CV%	4.93	9.82	9.78	9.199	10.38	9.95	11.27	12.895

Table 3: Fresh foliage yield and Dry foliage yield (kg/ha) of Kalmegh as influenced by different organic and chemical fertilizers treatments

Treatments	Fresh foliage yield (kg/ha)				Dry foliage yield (kg/ha)			
	2015-16	2016-17	2017-18	Pooled Mean	2015-16	2016-17	2017-18	Pooled Mean
Main plot Treatments : Organic manures								
M1- Control	3211	5384	4846	4480	1297	2156	4161	2538
M2- FYM 10 t ha ⁻¹	3540	6344	26172	5352	1417	2648	4378	2814
M3- FYM 15 t ha ⁻¹	3767	7064	7205	6012	1504	2923	4526	2984
M4- Vermicompost 5.0 t ha ⁻¹	3715	6768	6835	5773	1484	2842	4988	3105
M5- Vermicompost 7.5 t ha ⁻¹	3929	7376	7597	6301	1541	2996	4541	3026
M6- Castor cake 1.5 t ha ⁻¹	3477	6116	5994	5196	1385	2569	4993	2982
M7- Castor cake 2.5 t ha ⁻¹	3634	6509	6509	5551	1456	2734	4984	3058
SE (m) ±	48	115	118	83.909	31	48	142	42.517
CD (P=0.05)	147	355	365	258.572	96	149	439	131.020
Sub plot Treatments : Chemical fertilizers								
T1- Control	2948	5861	5740	4849	1167	2409	4427	2668
T2- 40:10:30 Kg/ha NPK	3386	6056	6087	5176	1354	2508	4664	2842
T3- 60:20:40 Kg/ha NPK	3603	6259	6212	5358	1421	2593	4462	2825
T4- 80:30:50 Kg/ha NPK	3753	6466	6414	5545	1497	2680	4329	2835
T5- 80:30:50 Kg/ha NPK (Half N with full P & K as basal and remaining half of N at 25 DAS)	3821	6754	6659	5745	1528	2801	4876	3069
T6- 80:30:50 Kg/ha NPK (Half N with full P & K as basal and remaining half N in two equal splits at 25 and 40 DAS)	3861	7025	6974	5953	1548	2914	4972	3145
T7- 80:30:50 Kg/ha NPK (Half N with full P & K as basal and remaining half N in three equal splits at 25, 40 & 60 DAS)	3900	7140	7073	6038	1567	2963	4840	3123
SE (m) ±	50	139.73	139.49	88.774	28	58.68	143.94	55.206
CD (P=0.05)	140	387.32	386.66	246.068	79	162.65	398.99	153.023
Interaction (A*B)								
SE (m) ±	133.45	369.70	369.07	88.774	75.20	155.25	380.84	55.206
CD (P=0.05)	NS	NS	NS	246.068	NS	NS	1056	153.023
CV%	6.40	9.84	9.91	12.757	9.04	9.98	14.18	14.96

Herbage yield, GMR, NMR and B: C; Ratio

Application of vermicompost @ 7.5 t ha⁻¹ recorded significantly higher fresh herbage yield (kg ha⁻¹). The dry

foliage yield per hectare with application of vermicompost @ 5 t ha⁻¹ was at par with application of vermicompost @ 7.5 t ha⁻¹ and application of castor cake 2.5 t ha⁻¹. Application of

80:30:50 Kg/ha NPK (Half N with full P & K as basal and remaining half N in three equal splits at 25, 40 & 60 DAS) (T₇) recorded significantly higher Fresh herbage yield per hectare. However, dry foliage yield was found significantly superior with application of 80:30:50 kg ha NPK (Half N with full P & K as basal and remaining half N in two equal splits at 25 and 40 DAS) (T₆) and treatments T₅ & T₇ were at par with each other. Interaction effects were significant in case of fresh & dry foliage yield per hectare.

The data on pooled means (Table-4 & 5) revealed that the interaction M₅T₆ of manure application vermicompost 5 t ha⁻¹ along with 80:30:50 Kg/ha NPK (Half N with full P & K as basal and remaining half N in two equal splits at 25, 40 & 60 DAS) chemical fertilizer application dose and time produced significantly highest herbage yield, GMR and NMR than other treatment combinations; however, it was at par with M₅T₆ and M₆T₆.

Table 4: Herbage yield (kg/ha) and GMR (Rs/ha) of Kalmegh as influenced by different organic and chemical fertilizers treatments

Treatments	Herbage yield (kg/ha)				GMR (Rs/ha)			
	2015-16	2016-17	2017-18	Pooled Mean	2015-16	2016-17	2017-18	Pooled Mean
Main plot Treatments : Organic manures								
M1- Control	1297	2156	4161	2538	74605	43128	83218	66984
M2- FYM 10 t ha ⁻¹	1417	2648	4378	2814	77404	52958	87559	72641
M3- FYM 15 t ha ⁻¹	1504	2923	4526	2984	85660	58466	90513	78213
M ₄ - Vermicompost 5.0 t ha ⁻¹	1484	2842	4988	3105	78989	56849	99752	78530
M ₅ - Vermicompost 7.5 t ha ⁻¹	1541	2996	4541	3026	81518	59918	90813	77417
M ₆ - Castor cake 1.5 t ha ⁻¹	1385	2569	4993	2982	78341	51378	99864	76528
M ₇ - Castor cake 2.5 t ha ⁻¹	1456	2734	4984	3058	78800	54673	99686	77720
SE (m) ±	31	48	142	42.517	3579	965	2850	1671
CD (P=0.05)	96	149	439	131.020	NS	2975	8782	5150
Sub plot Treatments : Chemical fertilizers								
T ₁ - Control	1167	2409	4427	2668	72838	48185	88532	69851
T ₂ - 40:10:30 Kg/ha NPK	1354	2508	4664	2842	77721	50154	93284	73719
T ₃ - 60:20:40 Kg/ha NPK	1421	2593	4462	2825	80739	51866	89249	73951
T ₄ - 80:30:50 Kg/ha NPK	1497	2680	4329	2835	77480	53605	86577	72554
T ₅ - 80:30:50 Kg/ha NPK (Half N with full P & K as basal and remaining half of N at 25 DAS)	1528	2801	4876	3069	82890	56017	97526	78811
T ₆ - 80:30:50 Kg/ha NPK (Half N with full P & K as basal and remaining half N in two equal splits at 25 and 40 DAS)	1548	2914	4972	3145	80633	58289	99434	79452
T ₇ - 80:30:50 Kg/ha NPK (Half N with full P & K as basal and remaining half N in three equal splits at 25, 40 & 60 DAS)	1567	2963	4840	3123	83016	59256	96802	79692
SE (m) ±	28	58.68	143.94	55.206	3250	1174	2879	1500
CD (P=0.05)	79	162.65	398.99	153.023	9008	3253	7980	4159
Interaction (A*B)								
SE (m) ±	75.20	155.25	380.84	55.206	8598	3105	7617	1500
CD (P=0.05)	NS	NS	NS	153.023	23833	NS	NS	4159
CV%	9.04	9.98	14.18	14.96	18.77	9.98	14.18	15.79

Table 5: NMR (Rs/ha) and B: C ratio of Kalmegh as influenced by different organic and chemical fertilizers treatments

Treatments	NMR (Rs/ha)				B:C ratio			
	2015-16	2016-17	2017-18	Pooled Mean	2015-16	2016-17	2017-18	Pooled Mean
Main plot Treatments : Organic manures								
M1- Control	51601	19133	59223	44404	3.23	1.80	3.50	2.8
M2- FYM 10 t ha ⁻¹	44040	18603	53204	38904	2.33	1.55	2.55	2.1
M3- FYM 15 t ha ⁻¹	47296	19111	51158	38161	2.23	1.48	2.31	2.0
M ₄ - Vermicompost 5.0 t ha ⁻¹	35625	12494	55397	35213	1.82	1.28	2.25	1.8
M ₅ - Vermicompost 7.5 t ha ⁻¹	28154	5563	36458	23349	1.53	1.10	1.67	1.4
M ₆ - Castor cake 1.5 t ha ⁻¹	36977	9023	57509	35120	1.89	1.21	2.37	1.8
M ₇ - Castor cake 2.5 t ha ⁻¹	25435	317	45330	23703	1.48	1.00	1.84	1.4
SE (m) ±	3579	965	2850	1671.09	0.08	0.02	0.06	0.03
CD (P=0.05)	NS	2975	8782	5149.60	NS	0.07	0.19	0.10
Sub plot Treatments : Chemical fertilizers								
T ₁ - Control	35098	10444	50792	32350	2.07	1.36	2.48	2.0
T ₂ - 40:10:30 Kg/ha NPK	38190	10270	53401	34219	2.09	1.33	2.53	2.0
T ₃ - 60:20:40 Kg/ha NPK	40197	10676	48059	33178	2.16	1.32	2.36	1.9
T ₄ - 80:30:50 Kg/ha NPK	35926	11107	44079	30598	1.91	1.31	2.17	1.8
T ₅ - 80:30:50 Kg/ha NPK (Half N with full P & K as basal and remaining half of N at 25 DAS)	40976	12799	54308	36087	2.15	1.35	2.38	2.0
T ₆ - 80:30:50 Kg/ha NPK (Half N with full P & K as basal and remaining half N in two equal splits at 25 and 40 DAS)	38359	14351	55496	36723	2.02	1.38	2.35	1.9
T ₇ - 80:30:50 Kg/ha NPK (Half N with full P & K as basal and remaining half N in three equal splits at 25, 40 & 60 DAS)	40382	14598	52144	35700	2.12	1.38	2.22	1.9
SE (m) ±	3250	1174	2879	1500.30	0.10	0.03	0.06	0.04

CD (P=0.05)	9008	3253	7980	4158.61	0.29	0.08	0.17	0.11
Interaction (A*B)								
SE (m) +	8598	3105	7617	1500.30	0.28	0.07	0.16	0.04
CD (P=0.05)	23833	NS	NS	4158.61	0.77	0.20	0.45	0.11
CV%	18.74	14.69	15.78	16.14	19.07	9.39	11.96	16.55

Conclusion

From the pooled data, it is revealed that the significantly higher fresh herbage, dry herbage yield and highest GMR was observed with application with Vermicompost @ 5 t/ha which is at par with application of with vermicompost @ 7.5 t/ha (M₅), and application of castor cake 2.5 t /ha. Herbage yield and GMR was significantly highest with application of (T₆) 80:30:50 Kg/ha NPK (Half N with full P & K as basal and remaining half N in two equal splits at 25, 40 & 60 DAS) as compared to control, 50%,75% and 100% of NPK application without split of N dose. However, T₆ was at par with (T₅) 80:30:50 Kg/ha NPK (Half N with full P & K as basal and remaining half of N at 25 DAS)and (T₇) 80:30:50 Kg/ha NPK (Half N with full P & K as basal and remaining half N in three equal splits at 25, 40 & 60 DAS. Interaction effect on application of manures and fertilizer dose application time showed significant effect on GMR, NMR and B:C ratio. GMR was significantly highest with M₄T₇ at par with M₄T₆ followed by M₇T₅. NMR and B:C ratio was significantly highest with (M₁T₅) Control and 80:30:50 Kg/ha NPK (Half N with full P & K as basal and remaining half of N at 25 DAS).

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