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Effect of Time of planting and Harvesting on Growth, Herbage yield and Andrographolide content in Kalmegh (*Andrographis paniculata* Nees.)

Himbindu T[1], Hariprasad Rao N [1], Satyanarayana Reddy G[2], Sastry K.P[3]
[1]College of Horticulture, Rajendranagar, Dr.Y.S.R.H.U, [2]Medicinal and Aromatic Plants Research Station, Rajendranagar, Dr.Y.S.R.H.U, [3]CSIR-Central Institute for Medicinal and Aromatic Plants, Hyderabad.

ABSTRACT
A field experiment was conducted to study the effect of time of planting and harvesting on growth, herbage yield and andrographolide content in Kalmegh at Vegetable Research Station, Rajendranagar, Hyderabad. The experiment was laid out in Factorial RBD and replicated thrice. There are 12 treatment combinations comprising of four dates of plating (1st July, 16thJuly, 1st August and 16th August) and three stages of harvesting (Pre flowering stage, Flowering stage and Pod setting stage). The results of the experiment revealed that the crop planted on 1st August recorded maximum values for plant height, number of branches per plant, number of leaves per plant, fresh and dry herb weight, dry herbage yield which were significantly superior over other planting treatments. Among different harvesting treatments the crop harvested at pod setting stage recorded maximum values for plant height, number of branches per plant, fresh and dry herb weight, dry herbage. Number of leaves per plant, and andrographolide content were, however, maximum with the crop harvested at flowering stage. The present study clearly indicated that planting on 1st August and harvesting at pod setting stage were superior over other planting and harvesting treatments with overall better performance in kalmegh.
Key Words: *Kalmegh, Dates of planting, stages of harvesting, herbage yield, HPLC, andrographolide.*

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INTRODUCTION

Kalmegh **(***Andrographis paniculata* Nees.**)** belonging to family Acanthaceae is an important medicinal plant originated at "The Isle of France". The plant is known as Mahatikta in Sanskrit, "Rice bitters" in West Indies and "King of bitters" in England [1]. The genus, *Andrographis* consists about 40 species of which 19 are indigenous to India. Among the species *A.paniculata* and *A.alata* have been reported to posses medicinal properties.

It is one of the most widely used plants in ayurvedic formulations and was recommended in Charaka Samhita dating to 175 BC for treatment of jaundice along with other plants in multi plant preparations. [2,3]. It is most popular as a remedy for a number of ailments related to hepatoprotection, digestion, vermicidal, analgesic, anti-inflammatory, anti-bacterial, anti-typhoid, hypoglycemic, besides immune enhancement. The plant is also a well known drug used for treating fever, diabetes, snake bite, common cold and a variety of ailments [4]. A study conducted in Indonesia has also revealed anti HIV activity of the crude extract from whole plant of kalmegh [5]. The drug is official in Indian pharmacopeia (Medicinal plants) and is prominent in at least 26 ayurvedic formulations. The therapeutic activities of the plant are attributed to andrographolide (a diterpene lactone) and related diterpenes.

The therapeutic activities of the plant are attributed to andrographolide (a diterpene lactone) and related diterpenes. The commercial demand for kalmegh is very high ad expected to grow voluminously. For ensuring quality raw material sustainable basic cultivation of this herb is desired. Inspite of its multifarious medicinal values, the crop is not widely grown on commercial scale in India. At present it is being collected at different stages of growth from the forest areas resulting in a lot of variation in the active principle content of the herb. Moreover the availability of the plant from the natural sources has also diminished considerably due to unscrupulous collection, necessitating the cultivation of this crop on commercial scale for obtaining the drug required by the industry. The present investigation is formulated to assess the optimum time of planting and harvesting of kalmegh.

MATERIAL AND METHODS

A field experiment was conducted during kharif season at Vegetable Research Station, Rajendranagar, Hyderabad. The experiment was laid out in Factorial RBD with 3 replications. There are 12 treatment combinations comprising of four dates of plating (1st July, 16thJuly, 1st August and 16th August) and three stages of harvesting (Pre flowering stage, Flowering stage and Pod setting stage). The seeds of variety CIM-Megha procured from CIMAP, Regional Research Station, Hyderabad were used for sowing. Forty five day old healthy and uniform seedlings were transplanted according to dates of planting. Gap filing was done on seventh day after planting by taking seedlings from the same treatment. Periodic weeding, irrigation and fertilizer application were carried out. The crop was harvested at different stages of growth *viz.*, pre-flowering, flowering and pod setting stages by cutting the stem close to the ground. Five plants at random from each net plot were selected and tagged for the purpose of recording observations on growth and yield parameters. Andrographolide content was estimated using HPLC procedure followed by Parasher *et al* [6]. The data collected on different parameters was subjected to statistical analysis outlined by Panse and Sukhatme [7].

RESULTS AND DISCUSSION

The data pertaining to growth, herbage yield and quality parameters as influenced by different dates of planting and stages of harvesting is presented in Table 1. Plant height, number of branches, number of leaves per plant, fresh and dry herb weights, dry herbage yield were significantly affected by dates of plating and recorded highest values for planting date of 1st August (D_3). Increased plant height (54.16) with the treatment could be attributed to favourable weather conditions which might have influenced the plants to grow taller by increasing cell division and cell elongation.

Maximum number of branches per plant (16.15) and leaves per plant (262.84) recorded with 1st August planting (D_3) could be attributed to the maximum plant height which might have favoured the formation of more lateral buds resulting in more number of branches there by more leaves. Increase in number of branches per plant with increase in plant height was also reported by Singh and Singh [8] and Sunil *et al.* [9] in kalmegh and Seghatoleslemi *et al*. [10] in roselle.

The treatment with planting date of 1st August was observed with maximum fresh herb weight. The possible reason for the increase in fresh herb weight (72.54) could be due to more number of leaves in the treatment which might have produced and translocated more photosynthates resulting in higher growth attributes *viz*., plant height and number of branches there by more fresh herb weight. Maximum dry herb weight (24.32) and dry herbage yield (3804.7) with 1st August plating could be attributed to higher fresh herb weight through increased plant height, more number of branches and leaves in the treatment.

Significant differences in growth, yield parameters and andrographolide content were observed due to stages of harvesting. Plant height, number of branches, fresh and dry herb weights and dry herbage yield showed continuous pattern of increase up to pod setting stage of harvest.

Plant height and number of branches per plant had shown an increasing trend from pre flowering stage of harvest to pod setting stage of harvest. This might be due to continuous growth pattern of kalmegh up to pod setting stage of harvest which might have helped in the production of plants with maximum height and more number of branches by formation of more lateral buds. Similar findings were also reported by Kaushal Kumar *et al*. [11] and Parashar *et al*. [6] in kalmegh.

Maximum number of leaves per plant (249.15) was observed at flowering stage of harvest and minimum (194.62) at pod setting stage of harvest could be attributed to increased growth traits (plant height and number of branches) which might have contributed to more leaves. The decline in number of leaves at pod setting stage of harvest might be due to abscission of lower leaves as a result of natural senescence. Similar findings were also reported by Ashok *et al*. [1] and Saida Naik [12] in kalmegh, Shamaraj *et al*. [13] in ashwagandha.

Maximum fresh herb weight (83.21) obtained by harvesting at pod setting stage may be attributed to the progressive pattern of increase in growth parameters from pre flowering stage of harvest to pod setting stage of harvest. Similar results were also obtained by Parashar *et al*. [4] in kalmegh.

Maximum dry herb weight (30.29) and dry herbage yield (4644.4) obtained at pod setting stage of harvest could be attributed to higher fresh herb weight as a result of higher growth parameters (plant height and number of branches) and also lignifications of tender shoots and branches at advanced stage of harvesting. The results are in confirmity with the findings of Ashok *et al.* [1], Seema Nemade *et al*. [14], Misra *et al*. [15] Bhan *et al*. [2], Parashar *et al*. [4], Singh *et al*. [8] in kalmegh,

Significant differences were observed among different stages of harvesting for andrographolide content of herbage. An increase in andrographolide content from pre flowering stage of harvesting to flowering stage was noticed and there after a decline at pod setting stage of harvest was observed. Maximum

andrographolide content (2.55) was recorded at flowering stage of harvest. Increased andrographolide content at flowering stage could be attributed to more number of leaves at that time which were reported to contain more andrographolide than stems and branches [4]. Although the content of andrographolide was higher in flowering stage of harvest, the dry herbage yield at pod setting stage of harvest is significantly higher over flowering stage resulting in higher andrographolide yield at pod setting stage of harvest.

The interaction between planting dates and harvesting stages significantly influenced different growth and yield parameters. The crop planted on 1st August and harvested at pod setting stage (D_3H_3) recorded maximum plant height, number of branches per plant, fresh and dry herb weight and dry herbage and yields which may be attributed to synergistic effect of planting date and harvesting stage. Number of leaves per plant was however, maximum with the crop planted on 1st August and harvested at flowering stage (D_3H_2).

The present study clearly indicated that planting on 1st August and harvesting at pod setting stage were superior to other planting and harvesting treatments with overall better performance in kalmegh.

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Table 1: Effect of different dates of planting and stages of harvesting on growth, herbage yield and adrographolide content in kalmegh.

Treatments	Plant Height (cm)	Number of branches	Number of leaves	Fresh herb weight (g plant^{-1})	Dry herb weight (g plant^{-1})	Dry herbage Yield (kg ha^{-1})	Andrographolide content (%)
Dates of Planting (D)							
D_1	38.90	12.42	189.00	56.57	18.71	2869.3	2.21
D_2	48.07	14.91	214.71	65.67	21.42	3284.4	2.28
D_3	54.16	16.15	262.84	72.54	24.32	3804.7	2.25
D_4	39.68	12.86	195.66	58.70	19.64	3011.5	2.23
SEm±	0.35	0.16	2.34	0.82	0.39	49.8	0.029
CD at 5%	1.02	0.47	6.87	2.42	1.14	146.0	N.S
Stages of Harvesting (H)							
H_1	39.15	12.08	202.88	46.97	12.98	2046.2	2.29
H_2	47.10	14.53	249.15	59.93	19.81	3036.8	2.55
H_3	49.35	15.65	194.62	83.21	30.29	4644.4	1.90
SEm±	0.30	0.14	2.02	0.71	0.33	43.1	0.025
CD at 5%	0.89	0.47	5.95	2.10	0.99	126.5	0.073
Interaction (D×H)							
D_1H_1	33.22	10.93	180.87	41.52	11.82	1812.4	2.25
D_1H_2	40.61	12.66	211.87	53.94	17.36	2661.8	2.51
D_1H_3	42.86	13.67	174.27	74.25	26.96	4133.9	1.86
D_2H_1	41.62	12.93	198.53	48.66	13.18	2020.9	2.32
D_2H_2	50.24	15.27	254.20	61.75	20.34	3118.8	2.58
D_2H_3	52.37	16.53	191.40	86.61	30.74	4713.5	1.94
D_3H_1	47.65	13.13	248.47	53.81	14.66	2474.8	2.30
D_3H_2	56.17	17.07	301.67	68.29	22.96	3520.5	2.55
D_3H_3	58.60	18.27	238.42	95.52	35.34	5418.8	1.91
D_4H_1	34.11	11.33	183.66	43.91	12.24	1876.8	2.27
D_4H_2	41.36	13.13	228.87	55.73	18.56	2845.9	2.54
D_4H_3	43.58	14.13	174.40	76.47	28.12	4311.7	1.89
SEm±	0.61	0.27	4.05	1.43	0.67	86.2	0.049
CD at 5%	1.78	0.82	11.90	4.21	1.99	252.9	N.S

D_1- 1st July planting, D_2 -16th July planting, D_3-1st August planting, D_4-16th August planting: H_1-Pre-flowering stage, H_2- Flowering stage, H_3- Pod setting stage

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