RESEARCH ARTICLE

EFFECT OF DIFFERENT FERTILITY LEVELS AND ROW SPACING ON GROWTH CHARACTERS OF KALMEGH

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Abstract: A field experiment was conducted during *kharif* season 2018-19 at Soil Conservation and Water Management farm of C. S. Azad University of Agriculture and Technology, Kanpur. The experiment was laid out in factorial randomized block design with 3 replications. Different fertilizer doses were given according to treatment i.e. F_1 (30:15), F_2 (60:30), F_3 (90:45), crop was transplanted by hand in the field according to the treatment. Plant to plant spacing was maintained as 20 cm, and row to row spacing was set as 30, 40 and 50 cm accordingly. Among the following treatment with fertilizer dose given as 90 kg N + 45kg P_2O_5 ha^{-1} (F_3) in combination with 40 cm row spacing (S_2) recorded highest growth and was significantly superior over all other treatments.

Keywords: Ayurvedic, Growth, Kalmegh, Medicinal crop

INTRODUCTION

The genus *Andrographis* consists of twenty six species, with maximum species diversity occurring in South India. Among them, *Andrographis paniculata* Nees, commonly known as "kalmegh" is an important medicinal crop, native to India and Sri Lanka. The kalmegh is also known as "king of bitters" in English meaning "dark cloud" and Bhunimba in Sanskrit. The total kalmegh herb yield is estimated to be 5,000 tonnes annually from the States of Assam, Bihar, Karnataka, Kerala, Madhya Pradesh, Andhra Pradesh, Uttar Pradesh and West Bengal. It can be cultivated on wide range of soils from loam to lateritic soils with moderate fertility. It can be cultivated on shady wastelands also. It required hot and humid climatic conditions with ample sunshine. Kalmegh is an erect herb, grows to a height of 30–90 cm, petiolated leaves, 2-3 cm long and 0.5-1.0 cm broad, lanceolate, hairy on the upper part, small whitish flowers borne on spreading racemes, fruit is capsule, 2 cm long and a few millimeters wide and contains several brownish yellow seeds.

Andrographolide is the chemical constituent of Kalmegh contains all part of the plants but the leaves of Kalmegh contain the highest amount. Kalmegh is a short duration crop and grown for medicinal purpose in *kharif* season and thus weed infestation is very high in this crop. Weeds deteriorate the quality and quantity of Kalmegh, so if we manage the weed properly then we can increase leaf area index, crop growth rate, and relative growth rate and herbage yield of plant. Hand weeding is best way control if availability of labour (Mrijha *et al*., 2003**).** The fresh and dried leaves of kalmegh and the juice extracted from the herb are official drugs in Indian pharmacopoeia. The whole herb is the source of several diterpenoids of which the bitter water-soluble lactone andrographolide is important and is distributed all over the plant body in different proportions. It is an active constituent in majority of Ayurvedic preparations and is official in the Ayurvedic Pharmacopoeia (Rammohan *et al.*, 2011).The leaves contain the maximum (2.5%) andrographolide content while the stem contains a smaller amount (2.0%) of active principle. In addition the plant is an important source of the flavonoids, sesquiterpenes, and phenylpropanoides. The roots contain the flavonoids, rographin,panicotin, aplegenin-4, 7-dimethyl ether, mono-omethylwightin, hydroxyl -7, 8, 2, 3-trimythoxy flavones and sitosterol. Phenyl propanoideugenol has also been recorded in the aerial part of the plant. The diterpenoid and sesquiterpenoid compounds occuring in *A. paniculata*have been referred to as paniculides and andrographolides. Besides the flavonoides, caffeic acid chlorogenic acid and dicaffeoyloquinic acids are also present in this plant.

The plant is considered to be highly efficacious against chronic malaria and often used as a substitute for Swertiachirata.The hot water extract of the whole plant is used for acute jaundice The plant has been reported to possess antipyretic, antihepatotoxic, antihistamic, analgesic, antibacterial, anti-inflammatory and antifertility properties due to its bitter and rographolide content. Due to pharmacological properties, Kalmegh herb is collected indiscriminately from wild sources causing a sharp decline in the availability of the herb to the industries. Very few studies have been carried out in the development of agro techniques for its commercial cultivation under different plant densities, spacing and nitrogen levels. As per earlier reports, quality of Kalmegh decreases with delay in

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harvesting whereas plant population exerts a marketed effect on yield potential indirectly by affecting soil and rhizosphericmicroflora especially the nitrogen fixing bacteria. Hence, proper nutrition is the key factor to enhance growth productivity and quality of Kalmegh.

MATERIALS AND METHODS

The experiment was laid out at Soil Conservation and Water Management farm which is situated just adjacent to main campus of university in the Gangetic alluvial plain zone of central Uttar Pradesh. It lies between 25^0 26' to 26^0 58' N latitude and 79^0 31' to 80^0 34' East longitude at an elevation of about 126.6 meters from mean sea level, average annual rainfall of about 834 mm, the most of which is received during monsoon season between last week of June to end of September with occasional showers in winter months. The soil of experimental field was a typical Gangetic alluvium falling under the textured class sandy loam. After field operation, soil sample were drawn randomly at 5 places in whole experimental area from 0-15 cm depth before sowing. The soil of all 5 samples was mixed together thoroughly and a composite reprehensive soil sample was prepared, The field was prepared by giving one ploughing with tractor drawn soil turning plough and two ploughing with tractor cultivator to pulverize the soil, planking was done after each ploughing in order to break the clods and to make soil friable., Different fertilizer doses were given according to treatment i.e. F_1 (30:15), F_2(60:30), F_3(90:45), crop was transplanted by hand in the field according to the treatment. Plant to plant spacing was maintained as 20 cm, and row to row spacing was set as 30, 40 and 50 cm accordingly. Nine treatments of *Andrographis. paniculata* were grown in randomized complete block design (RBD) with factorial concept in the field and observations were recorded for seven quantitative traits and Seed were used as planting material.

RESULTS AND DISCUSSION

Growth attributes

Plant growth attributes like plant height (cm)**,** number of leaves per plant**,** number of primary branches**,** number of secondary branches**,** collar diameter, leaf width, are the important parameters to assess the vigour of the plant. The results obtained under these growth attributes were accentuated and significantly influenced by different treatments under the present study.

a) Plant Height- The combined application of fertility levels and row spacing influenced plant height and also recorded favorable values. At all stages, the higher fertility levels of 90 kg N + 45kg P_2O_5 ha^{-1} (F_3) registered significantly highest plant height in comparisons to other two treatments. It is perhaps due to significant role of nitrogenous and phasphatic fertilizer in growth and development of kalmegh. Dhanush, S.L.*et al.* (2018) also obtained highest plant height with the fertility level of (90 kg N + 45kg P_2O_5 ha^{-1}).

b) Spacing- Among spacing, 40 cm row spacing ($S_{2)}$ recorded the highest plant height in comparison to S_1 and S_3 which were at par with each other. It is due to ideal spacing required to survive the kalmegh while more or less spacing badly influenced the plant height. In India, at Assam, significantly highest yield of Kalmegh was recorded at wider spacing (30 cm) by Makwana *et al.* (2009). Similarly, significantly higher growth was recorded in the spacing of 30 cm over other spacing levels by Pawar and Aher (2000), similar findings have also been reported by Ram *et al*. (2008) with row spacing 30 cm with plant population of 1.11 x 105 plants ha^{-1} recorded maximum plant height, than all other spacing.

c) Effect on primary and secondary branches-The fertility levels F_3 (90 kg N + 45kg P_2O_5 ha^{-1}) recorded higher number of primary branches which showed significant difference among all the treatments. In case of row spacing, 40cm (S_2) recorded higher number of primary branches which was significantly different with each other's. Experimental results were similar as reported by Ram *et al.* (2008) who observed that the maximum plant growth viz. number of primary and secondary branches and number of leaves/plant at spacing 30cm.

The fertility levels F_3 (90 kg N + 45kg P_2O_5 ha^{-1}) recorded higher number of secondary branches which was at par with F_2. Among spacing, S_2 recorded the highest number of secondary branches which showed a significant difference with each other. The results are closely similar with the findings of Pawar and Aher (2000).Chauhan *et al*., (2002) also reported maximum number of branches with the same fertility levels.

d) Number of leaves- The numbers of leaves were recorded at the fertility levels F_3 (90 kg N + 45kg P_2O_5 ha^{-1}) which exhibit significantly superior over all the treatments. Between spacing S_2 recorded higher number of leaves which was remained at par with S_1 and S_3 with each other. Similar findings have also been reported by Kanjilal *et al.* (2002) and Shohana (2007). These findings are in agreement with those of Singh *et al.* (2012), Utgikar *et al.* (2003) and Patidar *et al*. (2011).

e) Collar diameter (mm)-While spacing at all the stages of growth, spacing S_2 recorded the highest collar diameter in comparison to S_3 and S_1 were at par with each other. The maximum collar diameter were recorded at the fertility levels F_3 (90 kg N + 45kg P_2O_5 ha^{-1}) with combination of (S_2) as 40 cm row spacing, which exhibits significantly superior over all the treatments. These results are in full agreement with the findings of Anonymous (1992). Increase in collar diameter under wider row spacing might be attributed to competition of plants for light

and moisture which compelled them to grow faster towards the solar radiation.

f) Leaf width- Maximum leaf width were recorded with spacing S_2 which was remained at par with, S_1 and S_3 respectively. While among fertility levels maximum leaf width were recorded with fertility levels F_3 (90 kg N + 45kg P_2O_5 ha^{-1}) with combination of (S_2) as 40 cm row spacing) and remained at par with recorded the maximum leaf width which was significantly different with each other's, whereas, in case of fertility levels F_3 recorded higher values which was remained at par with. Similar findings have also been reported by Singh *et al.* (1999).

From the above discussion on growth parameters it is revealed that the treatment S_2F_3 (40 cm and 90 kg N + 45kg P_2O_5 ha^{-1}) had significant influence on all the growth attributes *viz*., plant height, number of branches and leaves. This effect due to wider spacing of plants, which help the individual plant to utilize more soil, water, nutrition, air and light for better growth in terms of plant height as compare to closer spacing. These findings are in agreement with those of Kanjilal *et al*. (2002). Similar findings have also been reported by Pawar and Aher (2000), Utgikar *et al*. (2003), Vijayaraghavan *et al*. (2005), Shohana (2007), Ram *et al*. (2008), Patidar *et al*. (2011) and Singh *et al*. (2012).

Table 1. Effect of spacing and fertility levels on plant height (cm) at 30,60,90 and 120 days after transplanting

Treatments	30 DAT	60 DAT	90 DAT	120 DAT
F_1 S_1	23.45	29.25	34.90	47.15
F_1 S_2	27.95	33.25	42.55	62.15
F_1 S_3	26.90	31.95	37.90	46.15
F_2 S_1	24. 59	32.35	36.65	55.10
F_2 S_2	28.35	39.36	38.80	65.75
F_2 S_3	27.25	37.15	33.65	52.75
F_3 S_1	25.35	34.75	40.10	57.95
F_3 S_2	28.65	40.15	39.23	78.15
F_3 S_3	27.80	38.45	37.20	54.85
SE(d)	0.88	1.61	1.10	2.07
CD(P=0.05)	NS	NS	2.34	4.38

Table 2. Effect of spacing and fertility levels on Primary branches at 30,60,90 and 120 days after transplanting

Treatments	30 DAT	60 DAT	90 DAT	120 DAT
F_1 S_1	8.25	9.35	10.85	13.77
F_1 S_2	8.71	9.91	11.05	17.30
F_1 S_3	7.39	9.77	10.41	14.42
F_2 S_1	9.15	11.55	12.99	16.17
F_2 S_2	9.77	12.75	14.15	22.30
F_2 S_3	7.46	11.72	12.81	18.71
F_3 S_1	9.31	12.79	13.85	18.21
F_3 S_2	9.91	14.19	15.70	25.81
F_3 S_3	9.12	12.46	14.35	22.78
SE(d)	0.61	0.68	0.70	1.22
CD(P=0.05)	NS	NS	NS	NS

Table 3. Effect of spacing and fertility levels on secondary branches at 30,60,90 and 120 days after transplanting

Treatments	30 DAT	60 DAT	90 DAT	120 DAT
F_1 S_1	3.41	7.70	10.21	11.75
F_1 S_2	5.65	10.15	12.45	14.65
F_1 S_3	5.80	9.65	12.21	14.05
F_2 S_1	4.62	9.25	10.29	14.01
F_2 S_2	5.80	10.62	13.15	17.20
F_2 S_3	6.05	9.95	12.65	16.07
F_3 S_1	5.55	9.73	11.97	15.15
F_3 S_2	7.15	11.38	14.05	17.45

F_3 S_3	6.45	10.65	13.45	16.75
SE(d)	0.71	0.73	0.72	1.25
CD(P=0.05)	NS	NS	NS	NS

Table 4. Effect of spacing and fertility levels on Number of leaves/plant at 30,60,90 and 120 days after Transplanting

Treatments	**30 DAT**	**60 DAT**	**90 DAT**	**120 DAT**
F_1 S_1	46.15	47.45	63.45	89.35
F_1 S_2	48.25	59.25	66.50	92.85
F_1 S_3	37.65	55.50	51.70	72.90
F_2 S_1	52.75	57.35	72.44	102.40
F_2 S_2	55.95	68.37	76.75	107.65
F_2 S_3	44.85	62.65	61.90	86.25
F_3 S_1	55.45	63.45	76.35	106.60
F_3 S_2	58.35	71.36	79.35	110.70
F_3 S_3	48.90	66.40	67.70	93.90
SE(d)	2.68	3.01	3.48	3.01
CD(P=0.05)	NS	NS	NS	NS

Table 5. Effect of spacing and fertility on collar diameter(mm) at 30,60,90 and 120 days after Transplanting

Treatments	**30 DAT**	**60 DAT**	**90 DAT**	**120 DAT**
F_1 S_1	3.30	3.45	4.10	5.81
F_1 S_2	3.55	3.80	4.25	6.10
F_1 S_3	2.35	3.55	3.75	5.19
F_2 S_1	3.45	3.59	4.45	6.42
F_2 S_2	3.66	4.60	5.11	8.01
F_2 S_3	2.60	3.89	3.90	6.15
F_3 S_1	3.50	3.65	4.59	7.22
F_3 S_2	3.72	4.72	5.23	9.03
F_3 S_3	2.79	3.98	3.98	6.35
SE(d)	0.13	0.27	0.27	0.56
CD(P=0.05)	N.S	N.S	NS	NS

Table 6. Effect of spacing and fertility Leaf Width (cm) at 30,60,90 and 120 days after Transplanting

Treatments	**30 DAT**	**60 DAT**	**90 DAT**	**120 DAT**
F_1 S_1	0.94	0.95	1.30	1.65
F_1 S_2	0.97	0.98	1.35	1.72
F_1 S_3	0.75	0.77	1.09	1.33
F_2 S_1	1.05	1.09	1.46	1.85
F_2 S_2	1.12	1.14	1.55	1.97
F_2 S_3	0.88	0.90	1.25	1.60
F_3 S_1	1.10	1.12	1.54	1.94

F_3 S_2	1.15	1.19	1.61	2.05
F_3 S_3	0.97	1.00	1.35	1.74
SE(d)	0.08	0.68	0.13	0.16
CD(P=0.05)	N S	NS	N.S	N.S

SUMMARY AND CONCLUSION

The data obtained from observations of growth and growth characters were processed, tabulated and subjected to statistical analysis by standards methods to draw valid conclusion from the study. The research results pertaining to each aspect have been presented and found that at all stages, the higher fertility levels of 90 kg N + 45kg P_2O_5 ha^{-1} (F_3) registered significantly highest in comparisons to other two(F_1 and F_2) treatments. It is perhaps due to significant role of nitrogenous and phasphatic fertilizer in growth and development of Kalmegh. Dhanush, S.L. *et al*. (2018).

Among spacing, 40 cm row spacing (S_2) recorded the highest growth characters in comparison to S_1 and S_3 which were at par with each other. It is due to ideal spacing required to survive the Kalmegh while more or less spacing badly influenced the growth.

Therefore, based on the research done , it can easily be recommended that in order to have high returns with growth and growth characters of Kalmegh 90 kg N + 45kg P_2O_5 ha^{-1} (F_3) in combination with 40 cm row spacing (S_2) should be practiced.

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