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Madan Lal Panwar
Garden Incharge, Herbal Garden Neri, Dept. of Ayurveda (Hamirpur) Himachal Pradesh, India

Dr. Aruna Mehta
Himalayan Research Associate, Department of Forest Products, University of Horticulture and Forestry, Nauni, Solan (HP), India

Dr. Vinod Kumar
Assistant Professor, Department of Forestry, VCSGUUHF, College of Forestry, Ranichauri, Tehri Garhwal, Uttarakhand, India

Dr. Meenu Sood
Principal Scientist, Department of Forest Products, University of Horticulture and Forestry, Nauni, Solan (HP)-173230, India., India

Correspondence
Dr. Aruna Mehta
Himalayan Research Associate, Department of Forest Products, University of Horticulture and Forestry, Nauni, Solan (HP), India, India

Effect of mulch and different spacings on seedling vigour of *Andrographis paniculata* under Himalayan mid hill regions

Madan Lal Panwar, Aruna Mehta, Vinod Kumar and Meenu Sood

Abstract
Andrographis paniculata has wide range of medicinal and pharmacological application. It is used in different systems of medicine and exhibit anti-malarial, antidiabetic, antipyretic, hepatoprotective, anti-inflammatory and anticancer etc., properties. Present study was conducted to investigate the effect of two treatments as 1) M_1-with dry grass mulch and, 2) M_2-without mulch under different line spacing levels viz.1) S_1-10cm, 2) S_2-15cm and 3) S_3-20cm on germination % and seedling vigour of *Andrographis paniculata*. The results revealed that significant higher germination %, survival percentage, number of leaves per seedling, root & shoot length, fresh root & shoot weight/seedling, dry root and shoot weight/ seedling was observed at 10cm line spacing using mulch as compared to control. Thus application of mulch can be a best option for obtaining uniform and healthy seedling vigour in *Andrographis paniculata*.

Keywords: *Andrographis paniculata*, mulching, line spacing, growth performance, germination, mid hill

Introduction
Andrographis paniculata (Family Acanthaceae) commonly known as Kalmegh, is an important medicinal plant also known as the king of the bitter [17]. It grows abundantly in Southeast Asian countries such as Sri Lanka, Pakistan, Malaysia and Indonesia and has been cultivated extensively for medicinal purpose in India, China, Thailand, East and West Indies and Mauritius [14, 15, 16, 18]. In India, it is grown in Assam, Bihar, Karnataka, Kerala, Madhya Pradesh, Andhra Pradesh and West Bengal [22]. *Andrographis paniculata* is best suited to hot and humid climatic conditions but it can be cultivated in subtropical regions during the monsoon season [18]. The species is widely used in various Ayurvedic formulations [10, 23] and recommended by National Medicinal Plant Board of India as one of the priority species for intensive cultivation [7]. The plant is particularly known for its bitter properties due to presence of bitter andrographaloides (alkaloid) content and is used traditionally as a remedy against common cold, dysentery, fever, tonsillitis, diarrhoea, lever diseases, inflammation, immune system, respiratory system, cardiovascular system [5, 14, 16, 30, 32] and also possesses anti-malarial [28], antidiabetic [3, 8], antipyretic [8], antihepatoprotective [31], antibacterial & antoxidant [8, 17], anti-inflammatory [26], antifertility [2], antihepatitis [25], anti-HIV [12], cardiovascular [4], anticancer [21], and immunostimulatory properties [13] which are attributed to its andrographolide content.

Being a subtropical species, commercial cultivation at present is prevalent in Madhya Pradesh, Uttar Pradesh, West Bengal and Bihar. There is increasing domestic as well as international demand for kalmegh in the treatment of different ailments which is largely met from cultivation however, production is not sufficient to meet present day requirement. As the demand for this herb is increasing, it is generally felt to expand its cultivation areas to ensure regular availability to the industry as well as to people associated with traditional system of medicines. Due to warming of climate, Himalayan region have become potential regions for its cultivation. Thus, present studies were carried out on effect of mulch and different line spacings on growth performance of *Andrographis paniculata* under mid hill conditions of Himachal Pradesh.

Materials and methods
These studies were conducted under mid hill conditions of Himachal Pradesh in the experimental field and laboratory of the Department of Forest Products, Dr Y.S Parmar University of Horticulture and Forestry, Nauni, Solan (HP). The soil of experimental area was sandy loam in texture having pH- 7.72, EC- 0.42 m mhos/cm and available nitrogen,

phosphorus, potassium, organic carbon was 315, 12.60, 285.97 kg/ha and 0.99%, respectively. Experiment comprised of treatments *viz.* 1) M_1 - with mulch and 2) M_2-without mulch and different spacing levels *viz.* 1) S_1-10cm, 2) S_2-15cm and, 3) S_3 -20cm. The experiment was laid out in RBD (3X2 Factorial) with two treatments and three replications. Data was recorded for germination percentage, seedling survival percentage, number of leaves per seedling, root length(cm), shoot length(cm), fresh root and shoot weight(g)/seedling, dry root and shoot weight(g)/seedling.

Results and discussion

Results of present study have been presented in Table 1 & 2. Results revealed significant effect of mulch with 10cm line spacing on germination% and seedling vigour of *Andrographis paniculata*. It is evident from the Table 1 that maximum germination (51.20 %) was recorded in S_1M_1 which was statistically higher than all other values. Minimum seed germination % of 25.08% was observed in S_3M_2. Seedling survival % lied between the minimum value of 74.58% recorded in S_2M_2 (which was statistically at par with S_3M_1 (84.36%) and maximum value of 88.41% in S_1M_1. Similarly, maximum number of leaves per seedling (28.29) was obtained in S_1M_1 with minimum (11.61) in S_3M_2. The results are supported by findings of Thakur *et al.* [29] who have also observed higher number of leaves in *Capsicum annum* by application of *Lantana* leaves and grass mulch as compared to unmulched treatments. Similarly, Abd El-Kader *et al.* [1] observed significantly higher number of leaves per plant in *Abelmoschus esculentus* under mulched treatments compared to the control. Further, results of Norman *et al.* [19] have also proved application of dry grass mulch as a best technique for obtaining the maximum number of leaf in *Abelmoschus esculentus* compared to the control plants. Root length lied between the minimum value of 6.95cm in S_3M_2 and maximum of 9.56cm in S_1M_1 (which was statistically at par with 8.21 cm in S_2M_1; 7.91cm in S_3M_1). Whereas, shoot length varied from 4.73 cm (S_3M_2) to 7.94cm (S_1M_1) which was statistically significant. Dauda [9] has also recorded significantly higher plant height in pepper on grass mulch compared to the control. As far as other parameters were concerned, fresh shoot weight/seedling ranged between 0.513g (S_2M_2) to 2.097g (S_1M_1) whereas, dry shoot weight/seedling ranged between 0.133g (S_3M_2) to 0.516g in S_1M_1 (statistically at par with (0.443 g in S_2M_2). Similarly, maximum fresh root weight /seedling (0.146g) was recorded in S_1M_1 which was statistically higher from all other values while, minimum fresh root weight/seedling (0.0567g) was recorded in S_3M_2. Dry root weight/seedling ranged lied between the minimum value of 0.023g (S_2M_2 & S_3M_2) and maximum of 0.060g in S_1M_1. The results clearly revealed that all parameters of seedling vigour responded better with application of mulch as compared to without mulch.

Among different spacing levels, more number of plants per unit area was observed under 10cm line spacing compared to 15 & 20cm line spacings. Such a phenomenon of higher yield at closer spacing has also been reported by Singh and Nand [27] in *Mentha spicata*. Mulching provides a favourable environment for growth which results in more vigorous, healthier plants which may be more resistant to pest injury. Increase in soil moisture content and temperature stimulate root and shoot growth which leads to greater plant growth. Therefore, mulched plants usually grow and mature more uniformally than unmulched plants [6, 24]. In present study, the increased soil moisture due to mulch treatment might have a positive effect on kalmegh seedling vigour growth. Similarly, Duppong *et al.* [11] have also observed an increase in soil moisture, and a significant decrease of daily average and maximum temperature under mulches, in particular under straw mulch. Othino [20] has also reported that grass and black polythene mulch treatment is better for soil moisture conservation thereby enhance growth performance than without mulch.

Conclusion

The experimental results have indicated that both closure spacing level and mulching had positive effect on growth and seedling vigour of kalmegh. All the growth parameters were significantly higher at closure spacing using mulch as compared to control. Improved soil moisture conservation, reduced soil temperature, reduced weed infestation and nutrient availability as a result of reduced leaching of nutrients provided by mulching might have contributed to the increased germination and seedling vigour of kalmegh; hence, amongst different levels of spacing, the use of 10cm line spacing along with application of grass mulch were the optimum and the effective for getting healthy as well as higher seedling vigour of *Andrographis paniculata* and this practice could be recommended for farmers for better production under mid hill conditions.

Table 1: Effect of mulching and different spacings on seed germination % and seedling vigour of *Andrographis paniculata.*

Treatments	Germination %			Seedling survival (%)			Number of leaves per plant			Shoot length (cm)			Root length (cm)		
	M_1	M_2	Mean	M_1	M_2	Mean	M_1	M_2	Mean	M_1	M_2	Mean	M_1	M_2	Mean
S_1	51.20 (45.69)	31.48 (34.12)	41.34 (39.91)	88.41 (70.48)	79.15 (62.88)	83.78 (68.68)	28.29	14.67	21.48	7.94	5.81	6.88	9.56	7.89	8.72
S_2	34.91 (36.19)	30.00 (33.21)	32.46 (34.70)	81.61 (64.76)	74.58 (59.74)	78.09 (62.25)	26.43	12.72	19.57	6.29	5.09	5.69	8.21	7.50	7.86
S_3	34.34 (35.85)	25.08 (30.04)	29.71 (32.94)	84.36 (66.73)	78.68 (62.58)	81.52 (64.66)	18.83	11.61	15.22	5.87	4.73	5.30	7.91	6.95	7.43
Mean	40.15 (39.24)	28.85 (23.46)		84.79 (67.32)	77.47 (61.73)		24.52	13.00		6.70	5.21		8.56	7.45	
CD 0.05%															
Mulching	2.02			3.13			2.40			0.91			1.48		
Spacing	3.18			3.84			2.94			1.12			1.81		
MXS	3.50			5.42			4.16			1.58			2.55		

*Figures in the parenthesis denotes Arc Sine transformed values

Table 2: Effect of mulching and different spacings on seedling vigour of *Andrographis paniculata.*

Treatments	Fresh shoot weight (g)/seedling			Dry shoot weight (g)/seedling			Fresh root weight (g)/seedling			Dry root weight (g)/seedling		
	M_1	M_2	Mean	M_1	M_2	Mean	M_1	M_2	Mean	M_1	M_2	Mean
S_1	2.097	0.766	1.431	0.516	0.196	0.356	0.146	0.073	0.109	0.060	0.033	0.046
S_2	1.050	0.513	0.781	0.443	0.147	0.295	0.093	0.063	0.078	0.053	0.023	0.038
S_3	1.673	0.623	1.148	0.253	0.133	0.193	0.119	0.0567	0.343	0.037	0.023	0.030
Mean	1.606	0.634		0.404	0.159		0.119	0.234		0.050	0.025	
CD 0.05%												
Mulching	0.540			0.043			0.001			0.011		
Spacing	0.661			0.053			0.014			0.013		
MXS	0.935			0.075			0.020			0.019		

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