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Influence of Spacing, Manure and Fertilizer Applications

on the growth of *Atropa acuminata* in Kashmir Himalayas

The present investigation was conducted at Faculty of Forestry, SKUAST-Kashmir, during the year 2019. The experiment was laid out in a randomized block design with three replications. Four spacings (15×15 cm, 30 × 30 cm, 30 × 45 cm and 45 × 45 cm) and four fertility levels (Control, FYM@10t/ha, FYM@ 15t/ha and RDF (NPK 50:40:20 kg/ha) were evaluated. The results revealed that maximum plant height (90.59 cm), root length (27.11 cm) and root weight (39.58 grams) were recorded in seedlings spaced at 30 cm x 45 cm receiving FYM 15tha^{-1}. Seedlings planted at a spacing of 45 cm x 45 cm under the influence of FYM 15tha^{-1} registered the maximum values for number of leaves (94), leaf weight (47.37 grams) and shoot weight (78.27 grams).

Key words : *Atropa acuminata,* Sapacing, Manure, Growth.

Optimal growth of Atropa acuminata was achieved by planting seedlings at 30×45 cm spacing combined with 15 t/ha FYM.

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Introduction

Atropa acuminata is one of the important and threatened species which belong to the family Solanaceae (Kumar and Hamal, 2011). *Atropa acuminata* is commonly known as Maitbrand in Kashmiri and in Hindi it is known as Sagangur and Angurshefa. It is a tall perennial herb, 0.7-1.7m in height with dichotomously branch system. *Atropa acuminata* is endemic to India and is known as Indian Belladonna (Kaif *et al*., 2021). It occurs naturally in Western Himalayan ranges, extending from Kashmir at the altitude of 1,800-3,600m above sea level to the adjoining hills of the Himachal Pradesh up to 2500m above sea level. In North West Himalaya it is distributed in Kashmir, Muzaffarabad and Chakrata (Wani *et al*., 2007). It has also been reported from certain parts of Europe and North Persia.

Atropa acuminata is useful medicinally because of presence of tropane alkaloid in roots and leaves. All parts of the plant are analgesic, antispasmodic, hallucinogenic, mydriatic, narcotic and sedative. This is also used especially in cases where there is localized and painful inflammation that radiates heat. The roots and leaves of *Atropa acuminata* are used in India as anodyne, diuretic, mydriatic, narcotic and sedative (Maqbool *et al.,* 2014). At present Atropa is routinely raised through seed, the quality of stock is very poor due to dormancy and low germination.

Application of organic manures alone or with inorganic fertilizer helps to improve soil productivity and maintain soil fertility. Fulfillment of nutritional requirements of the crop is essential for achieving the higher yields. Optimum fertilizer dose varies with soil and agro climate condition. It is obvious that the production and productivity of cotton can be improved by introduction of higher yielding genotypes coupled with suitable agronomic practices like maintenance of optimum/ideal plant density. Use of optimum dose of fertilizers and timely control of insect pest as well as proper weed and water management Practices.

Keeping in view the importance and in order to protect the wealth of

our medicinal plants and also to encourage cultivation of genuine plant species of medicinal value, the present study was conducted.

Material and Methods

Study area

The present study was conducted in the Faculty of Forestry, SKUAST-Kashmir, Benhama Village (Tehsil-Lar, District Ganderbal). The site lies on the southern aspect at 34º 16′44″ N latitude and 74º46′31″ E longitude. The study site is located at an elevation of 1,783m (5850 feet) amsl having an area of 50 hac. The study area has temperate climate experiencing four distinct seasons: a severe winter (December to February), a cold spring (March to May), a mild summer (June to August) and a pleasant autumn (September to November). The site falls in a mid to high altitude characterized by hot summer and very cold winters. The mean meteorological data for the plantation season was obtained from meteorological observatory Ganderbal. The Average precipitation is 690 mm most of which is received from December to April in the form of snow and rains. The minimum temperature ranged from 3.4 to 14.1º C and the maximum temperature from 21.7 to 32.5ºC and the average maximum relative humidity from 70.4 to 90.8 percent, whereas mean minimum relative humidity ranged from 37.1 to 80.1 per cent during the research.

Methodology

The experiment was laid out in a randomized block design with three replications. Four spacings and four fertility levels were evaluated. The seedling raised in trays were transplanted in the first week of April. Planting of seedlings was done manually. Hand weeding was applied for removal of weeds.

Treatments

The details of the treatments comprising four levels of spacing and four fertilizer and manure doses are given below:

Spacing: 04

S1: 15×15 cm
S2: 30 × 30 cm
S3: 30 × 45 cm
S4: 45 × 45 cm

Manure/Fertilizer: 04

F1: Control
F2: FYM 10t/ha
F3: FYM 15t/ha
F4: RDF (NPK 50:40:20 kg/ha)

Treatment combination: 16

The details of different treatment combinations are presented below :

Layout of Replication I.

S1 × F1	S1 × F2	S1 × F3	S1 × F4
S2 × F1	S2 × F2	S2 × F3	S2 × F4
S3 × F1	S3 × F2	S3 × F3	S3 × F4
S4 × F1	S4 × F2	S4 × F3	S4 × F4

Spacing : 04
Manure/Fertilizer : 04
No. of Replications : 03
Experimental Design : Randomised Complete Block design (RCBD)

The observations were recorded with respect to Plant height(cm), No. of leaves (No), Leaf weight (gm), Shoot weight (gm), Root length (cm) and Root dry weight (gm).

Data analysis

The data collected in the field was analyzed using R-studio software (version 3.2.2). The variation between various factors and their interaction were tested at 5 per cent level of significance by subjecting the data to statistical analysis as per the standard statistical procedure.

Results and Discussion

The data regarding growth parameters *viz.* Plant height, No. of leaves, Leaf weight, Shoot weight, Root length and Root dry weight are presented in Table 1-6.

Plant height (cm)

The seedlings were out planted in the field under different spacing. The perusal of data in Table 1 revealed that spacing, manure and fertility level had a significant effect on the plant height of *Atropa acuminata.* It was found that maximum plant height of 83.75 cm was observed when *Atropa acuminata* seedlings were planted at a spacing of 30 cm x 45 cm followed by 81.80 cm under the spacing of 45 cm x 45 cm. Minimum value for plant height (71.76 cm) was observed for 15 cm x 15 cm.

A critical review of data in Table 1 revealed that significantly maximum plant height of 85.53 cm was recorded in seedlings receiving 15 t FYM ha^{-1}. This was however followed by 10 t FYM ha^{-1} (79.78 cm) and RDF (77.46 cm). the significantly minimum value of 75.99 cm was observed in seedling under control conditions.

It is evident from the data in Table 1 that maximum plant height of 90.59 cm was recorded in seedlings raised at a spacing of 30 cm x 45 cm and receiving 15 t FYM ha^{-1} which was however closely followed by S_4F_3 (88.42 cm) and S_2F_3 (83.57 cm). The minimum value of 71.57 cm was observed in seedlings raised at a spacing of 15 cm x 15 cm under control.

Number of leaves

It is evident from the average data in Table 2 that spacing, manures and fertility level had significant effect

Table 1: Effect of spacing, manures/fertilizer on plant height of *Atropa acuminata*

Spacing	Manure/Fertilizer				Mean
	Control	FYM 10 t/ha	FYM 15 t/ha	RDF (NPK 50:40:20 kg/ha)	
15 x 15 cm	71.57	75.25	79.55	73.47	74.96
30 x 30 cm	74.31	78.72	83.57	76.44	78.26
30 x 45 cm	79.59	83.46	90.59	81.35	83.75
45 x 45 cm	78.50	81.69	88.42	78.59	81.80
Mean	**75.99**	**79.78**	**85.53**	**77.46**	
		C.D. (p≤0.05)			
		Manure/Fertilizer:	**0.953**		
		Spacing:	**0.953**		
		F x S:	**N.S**		

on the number of leaves of *Atropa acuminata.* Number of leaves increases with increase in spacing. It was found that maximum number of leaves *i.e.*, 88.25 was observed when *Atropa acuminata* seedlings were planted at a spacing of 45 cm x 45 cm followed by 86 under the spacing of 35 cm x 45 cm. Minimum value for number of leaves (76.50) was observed for 15 cm x 15 cm.

Average Data in table 2 depicts that significantly maximum number of leaves (87.25) was recorded in seedlings receiving 15 t FYM ha^{-1}. This was however followed by 10 t FYM ha^{-1} (82) and RDF (80.50). The significantly minimum value of 76 was observed in seedling under control conditions.

A cursory glance of average data in Table 2 indicated maximum number of leaves (94.00) was recorded in seedlings spaced at 45 cm x 45 cm, receiving 15 t FYM ha^{-1}. The minimum number of leaves observed was 72 recorded at 15 cm x 15 cm spacing under control conditions.

Leaf weight

The data in Table 3 depicted that significantly maximum value of 42.58 grams was recorded in the spacing of 45 cm × 45 cm followed by 40.80 grams was recorded in the spacing of 30 cm × 45 cm and the minimum leaf weight (28.37grams) was recorded in the minimum spacing of 30 cm × 30 cm respectively.

Average Data in Table 3 depicts that significantly maximum leaf weight of 40.48 grams was recorded in

Table 2 : Effect of spacing, manure/fertilizer on No. of leaves of *Atropa acuminata.*

Spacing	Manure/Fertilizer				Mean
	Control	FYM 10 t/ha	FYM 15 t/ha	RDF (NPK 50:40:20 kg/ha	
15 x 15 cm	72.00	76.00	81.00	75.00	76.00
30 x 30 cm	74.00	79.00	85.00	78.00	79.00
30 x 45 cm	77.00	85.00	89.00	82.00	83.25
45 x 45 cm	83.00	89.00	94.00	87.00	88.25
Mean	**76.50**	**82.25**	**87.25**	**80.50**	
		C.D. (p≤0.05)			
		Manure/Fertilizer :	**1.482**		
		Spacing:	**1.512**		
		F x S:	**N.S**		

Table 3 : Effect of spacing, manures/fertilizer on leaf weight of *Atropa acuminata.*

Spacing	Manure/Fertilizer				Mean
	Control	FYM 10 t/ha	FYM 15 t/ha	RDF (NPK 50:40:20 kg/ha	
15 x 15 cm	26.34	28.69	30.75	27.71	28.37
30 x 30 cm	30.66	33.42	37.54	32.32	33.48
30 x 45 cm	37.61	40.65	46.26	38.70	40.80
45 x 45 cm	38.60	42.54	47.37	41.80	42.58
Mean	**33.30**	**36.33**	**40.48**	**35.13**	
		C.D. (p≤0.05)			
		Manure/Fertilizer:	**1.021**		
		Spacing:	**1.340**		
		F x S:	**N.S**		

seedlings receiving 15 t FYM ha^{-1} followed by 10 t FYM ha^{-1} (36.33 grams) and RDF (35.13 grams). The significantly minimum value of 33.30 grams was observed in seedling under control conditions.

It is evident from the data in Table 3 that maximum leaf weight of 47.37 grams was recorded in seedlings raised at a spacing of 45 cm x 45 cm and receiving 15 t FYM ha^{-1} which was however closely followed by S_3F_3 (46.26 grams) and S_4F_2 (42.54 grams). The minimum value of 26.34 grams was observed in seedlings raised at a spacing of 15 cm x 15 cm under control.

Shoot weight

The Table 4 reveals that the maximum Shoot weight of 74.11 grams was recorded in the spacing of 45 cm × 45 cm followed by 73.02 grams was recorded in the spacing of 30 cm × 45 cm and the lowest shoot weight 61.83 grams was recorded in the spacing of 15 cm × 15 cm, respectively.

Average Data in Table 4 depicts that significantly maximum shoot weight of 73.17 grams was recorded in seedlings receiving 15 t FYM ha^{-1} followed by 10 t FYM ha^{-1} (68.72 grams) and RDF (67.75 grams). The significantly minimum value of 65.44 grams was observed in seedling under control conditions.

A perusal of data in Table 4 showed that the interaction effect of spacing, manures and fertility level exert a non-significant effect on the shoot weight is presented in Table 4. However the maximum shoot weight 78.27 grams was recorded in seedlings spaced at 45 cm x 45 cm receiving 15 t FYM ha^{-1} which was followed by S_3F_3 (77.12 grams) and S_4F_2 (74.37 grams). The significantly minimum shoot weight of 58.60 grams was observed in seedlings spaced at 15 cm x 15 cm under control.

Root length

The data in Table 5 revealed that the maximum root length 23.40 cm was recorded in seedlings planted at 30 cm x 45 cm spacing. Comparatively minimum root length (17.91 cm) was observed in seedlings planted at 15 cm × 15 cm spacing.

An inquisition of data in Table 5 revealed that root growth was significantly affected by spacing, manures and fertility level. The maximum Root length (24.67 cm) was recorded when seedlings received FYM 15t / ha followed by 10 t FYM ha^{-1} (22.80 cm) and RDF (20.90 cm). The significantly minimum root length (16.10 cm) was recorded in seedlings under control treatment.

A perusal of data in Table 5 revealed that interaction between Spacing, manures and fertility level exert non-significant effect on root length. Though non-significant, maximum root length of 27.11 cm was recorded in seedlings planted at a spacing of 30 cm x 45 cm under the influence of FYM 15 t / ha. This was however, followed by root length of 26.03 cm when seedlings were

Table 4: Effect of spacing, manure/fertilizer on shoot weight of *Atropa acuminata.*

Spacing	Manure/Fertilizer				Mean
	Control	FYM 10 t/ha	FYM 15 t/ha	RDF (NPK 50:40:20 kg/ha	
15 x 15 cm	58.60	61.51	66.63	60.59	61.83
30 x 30 cm	63.31	65.80	70.67	64.72	66.13
30 x 45 cm	69.49	73.20	77.12	72.28	73.02
45 x 45 cm	70.37	74.37	78.27	73.43	74.11
Mean	**65.44**	**68.72**	**73.17**	**67.75**	
		C.D. ($p \leq 0.05$)			
		Manure/Fertilizer:	**0.889**		
		Spacing:	**0.989**		
		F x S:	**N.S**		

Table 5: Effect of spacing, manure/fertilizer level and their interaction on root length of *Atropa acuminata.*

Spacing	Manure/ Fertilizer				Mean
	Control	FYM 10 t/ha	FYM 15 t/ha	RDF (NPK 50:40:20 kg/ha	
15 x 15 cm	14.01	18.53	21.55	17.56	17.91
30 x 30 cm	16.00	22.41	24.00	20.01	20.60
30 x 45 cm	17.58	25.80	27.11	23.14	23.40
45 x 45 cm	16.83	24.49	26.03	22.89	22.56
Mean	**16.10**	**22.80**	**24.67**	**20.90**	
		C.D. ($p \leq 0.05$)			
		Manure/Fertilizer:	**0.846**		
		Spacing:	**0.968**		
		F x S:	**N.S**		

planted at a spacing of 45 cm x 45 cm receiving manure level of FYM 15t/ha. The significantly minimum Root length (14.01 cm) was observed in seedlings planted at a spacing of 15 x 15 cm under control conditions.

Root weight

The data in Table 6 depicted that significantly maximum value of 35.18 grams was recorded in the spacing of 30 cm × 45 cm followed by 34.59 grams was recorded in the spacing of 45 cm × 45 cm and the minimum root weight (29.28grams) was recorded in the minimum spacing of 30 cm × 30 cm respectively.

Average Data in Table 6 depicts that significantly maximum root weight of 37.40 grams was recorded in seedlings receiving 15 t FYM ha^{-1} followed by 10 t FYM ha^{-1} (34.65grams) and RDF (32.28 grams). The significantly minimum value of 33.30 grams was observed in seedling under control conditions.

It is evident from the data in Table 6 that maximum root weight of 39.58 grams was recorded in seedlings raised at a spacing of 30 cm x 45 cm and receiving 15 t FYM ha^{-1} which was however closely followed by S_4F_3 (38.38 grams) and S_2F_3 (37.86 grams). The minimum value of 24.20 grams was observed in seedlings raised at a spacing of 15 cm x 15 cm under control.

Discussion

Spacing of seedlings influenced all seedling growth parameters. The parameters *viz.*, Plant height, root length and root weight showed significant increase in growth attributes with the increase in spacing upto 30 cm x 45 cm. Similar trend of results were observed by (Joy *et al*., 2002) for *Alpinia galanga* where they found maximum plant height (88.44 cm) under 40 x 30 cm spacing. The number of suckers per clump and number of leaves per sucker were highest (68.51 and 10.76, respectively) with 60 x 60 cm spacing. The results are in accord with the findings of Alemu (2017) in *Ocimum basilicum* L. Similar results have been reported by Patel and Kushwaha (2013) who recorded the tallest plant height (50.66cm) of Ocimum species at plant spacing of 45cmx30cm followed by (48.13cm) at 50cmx30cm. Hegazy *et al.* (2008) in *Conocarpus erectus* and Vidhya (2012) in *Casuarina* hybrid. Number of leaves and biomass also increased in wider spacing. Eltayb *et al*. (2013) who recorded higher values of height, number of leaves, number of branches and survival in wider spacing as compared to narrow spacings. The high number leaves and branches per plant at the wider planting space compared to those of narrow planting space designates the effect of competition on foliage yield and growth.

Maximum plant height (90.59), root length of 27.11 cm and root weight (39.58 grams) were recorded in seedlings planted at a spacing of 30 cm x 45 cm under the influence of FYM 15 t ha^{-1}. This was however, followed by plant height of 88.42 cm, root length (26.03 cm) and root weight (38.38 grams) when seedlings were planted at a spacing of 45 cm x 45 cm receiving fertility level of FYM 15t ha^{-1}. The significantly minimum plant height of 71.57 cm, root length (14.01 cm) and root weight (24.20 grams) were observed in seedlings planted at a spacing of 15 x 15 cm under control. Similarly the data was analyzed for number of leaves, leaf weight and shoot weight and it was observed that maximum number of leaves (94.50), leaf weight (47.37 grams) and shoot weight (78.27 grams) were recorded in seedlings planted at a spacing of 45 cm x 45 cm under the influence of FYM 15 t ha^{-1}. The significantly minimum number of leaves (72.50), leaf weight (26.34 grams) and shoot weight (58.60 grams) were observed in seedlings planted at a spacing of 15 x 15 cm under control. These results also get support from the work of Verma *et al*. (2017) which reported that Root length of *Majorana hortensis* L. and *Origanum vulgare* species was also under significant influence of Vermicompost + soil + FYM in ratio is 1:1:1. The highest root length recorded on marjorum was 10.16 cm and 11.20 cm on oregano compared to significantly lower value of 8.10 cm and 6.20 cm in the control plants, respectively. Organic manure may develop soil aggregate and its granulating. Organic manure may decrease fluctuation of soil temperature further root initiation and root growth become easier to the particular depth so that plant grows well and may absorb more water and nutrients (Jo,

Table 6 : Effect of spacing, Manure/Fertilizer and their interaction on root weight of *Atropa acuminata.*

Spacing	Manure/Fertilizer				Mean
	Control	FYM 10 t/ha	FYM 15 t/ha	RDF (NPK 50:40:20 kg/ha	
15 x 15 cm	24.20	30.86	33.78	28.30	29.28
30 x 30 cm	28.01	34.67	37.86	32.84	33.34
30 x 45 cm	30.21	36.93	39.58	34.01	35.18
45 x 45 cm	29.86	36.14	38.38	33.98	34.59
Mean	28.07	34.65	37.40	32.28	
		C.D. ($p \leq 0.05$)			
		Manure/Fertilizer (F):	**0.787**		
		Spacing (S):	**0.765**		
		F x S:	**N.S**		

1990). There is evidence that growth parameters of shankhpushpi (*Evolvulus alsinoides*) were enhanced significantly under treatments of farmyard manure (Saharan *et al*., 2001). Joy *et al*., 2002 working with *Alpinia galangal* revealed that the FYM recorded the highest number of clumps per plot (19.17), plant height (90.18 cm), number of suckers per clump (57.10), number of leaves per sucker (10.23), fresh rhizome yield (45.14 t/ha), and oil yield (94.80 litres/ha). According to Bano *et al*. (2017) length of roots was influenced significantly ($p<0.01$) by the application of Farmyard manure (FYM). This is because organic matter uptake can increase soil nutrition content and its absorbing capacity and at the same time, it enhances nitrogen equilibrium and phosphorous absorption efficiency. Sharma *et al*., 2009 also reported that FYM dose of 150 q/ha was found best for maximum rhizome yield/plant, rhizome diameter, fresh herbage yield/plant, herbage yield/plot, plant height and plant spread. Kumar *et al*., 2012 stated that root dry weight of *Withania somnifera* remained highest (7.6 g/plant) in the plants treated with FYM @ 3 kg, vermi-compost @ 2 kg/plot and inoculated with Azospirillum @ 105 CFU.

Conclusion

The parameters *viz*., Plant height, root length and root weight showed significant increase in growth attributes with the increase in spacing upto 30 cm x 45 cm. The maximum plant height Root length and Root weight (were recorded in seedlings planted at 30 cm x 45 cm spacing. Growth parameters like Number of leaves, leaf weight and shoot weight significantly increased with increased spacing. The maximum values for number of leaves, leaf weight and shoot weight were recorded under 45 cm x 45 cm. The manure/fertilizer showed significant effect on all growth parameters The maximum plant height, number of leaves, leaf weight, shoot weight, root length and root weight was recorded in seedlings supplied with 15 t FYM ha^{-1}. The results revealed that significantly maximum plant height, root length and root weight were recorded in seedlings planted at a spacing of 30 cm x 45 cm under the influence of FYM 15 t ha^{-1}. Thus it is recommended that seedlings of this species can be planted at a spacing of 30 cm x 45 cm under the influence of FYM 15 t ha^{-1}.

कश्मीर हिमालय में *एट्रोपा एक्यूमिनाटा* की वृद्धि पर दूरी, गोबर खाद एवं उर्वरक अनुप्रयोगों का प्रभाव

मोहम्मद कैफ, अमरजीत सिंह, आसिफ अली गटू, ओयास अहमद वगै, तनवीर अहमद राठर एवं जौहर रफ़ीक

सारांश

वर्तमान अध्ययन 2019 में SKUAST-कश्मीर के वानिकी संकाय में किया गया। प्रयोग को रैंडोमाइज्ड ब्लॉक डिजाइन (RBD) में तीन पुनरावृत्तियों के साथ स्थापित किया गया। इसमें चार प्रकार की रोपण दूरियाँ (15×15 सेमी, 30×30 सेमी, 30×45 सेमी और 45×45 सेमी) तथा चार उर्वरता स्तर (नियंत्रण, गोबर खाद @10 टन/हेक्टेयर, गोबर खाद @15 टन/हेक्टेयर एवं अनुशंसित मात्रा में रासायनिक उर्वरक NPK @ 50:40:20 किग्रा/हेक्टेयर) का मूल्यांकन किया गया। परिणामों से ज्ञात हुआ कि 30×45 सेमी दूरी पर रोपे गए पौधों को जब गोबर खाद @15 टन/हेक्टेयर दी गई, तब अधिकतम पौधों की ऊँचाई (90.59 सेमी), जड़ की लंबाई (27.11 सेमी) एवं जड़ का वजन (39.58 ग्राम) प्राप्त हुआ। वहीं, 45×45 सेमी की दूरी पर रोपित पौधों को गोबर खाद @15 टन/हेक्टेयर देने पर अधिकतम पत्तियों की संख्या (94), पत्तियों का वजन (47.37 ग्राम) एवं तनों का वजन (78.27 ग्राम) दर्ज किया गया।

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