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Studies on seed germination pattern and effect of sowing date with planting prototype on *Valeriana jatamansi* (Jones): a rare medicinal plant of eastern Himalaya

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ABSTRACT

Valeriana jatamansi (Jones) is a high value threatened medicinal plant of Himalayan region. It is distributed from Afghanistan to southwest China and Burma. This plant is found growing from 1000 to 2500 m altitude in cold and shady places. Present investigation was conducted during the period of 2009-2013, at Regional Research Station (Hill Zone), under the aegis of Uttar Banga Krishi Viswavidayalaya at Kalimpong (1250 m asl). Objective of the present investigation was to know the effect of various plant growth hormone on seed germination and influence of time of sowing and crop geometry on growth and economic yield of Valeriana jatamansi. Among the hormonal treatments, maximum seed germination was observed with KNO_3 (0.2%) (79.00 ± 2.60) which was significantly superior to rest of the treatments. Thiourea (0.3%) treated seeds took least time to start germination and was at par with kinetin 200 ppm and KNO_3 (0.2%). Transplanting of seedlings during the first week of June gave good response on fresh aerial biomass at 12, 15, 18, 21 and 24 month stage. Appreciably more fresh weight was recorded with the 30 x 45 cm spacing, Least biomass was recorded with closer spacing. Maximum underground biomass was recorded with June transplanting with spacing of 30 × 45 cm which was at par with the spacing 30 x 30 cm spacing. Date of transplanting failed to produce any significant effect on fresh rhizome biomass at all the stages of observation, except at 9 month stage where July transplanting produced significantly more rhizome biomass compared to June transplanting of seedlings. Maximum underground rhizome biomass was recorded with 30 × 45 cm spacing, and was at par with 30 × 30 cm spacing at 12, 15, 18 and 21 month stages. Maximum root biomass was recorded with June transplanting, throughout the stage of observation, and significantly better response to other set of time. More root growth was recorded with 30 × 45 cm and it was statistically at par with the 30 x 30 cm spacing at 15, 18, 21 and 24 months and significantly superior to closer spacing.

Keywords **:** Crop geometry, growth hormone, planting time, seed germination, *Valeriana jatamansi*

Valeriana jatamansi (Jones) is one of the most important medicinal herb of the western to eastern Himalayan grown at an altitude of 1200 - 2000 m (Mukherjee *et al*., 2013). It is distributed from Afghanistan to southwest China, Burma and few part of Indian Himalayan range. It is an important medicinal herb used in the treatment of epilepsy, leprosy, hysteria and asthma. The active principle of this plant, besides having antibacterial and antiprozal activity, can be taken as a remedy for snake bite as well as scorpion sting. Locally it is being used for medicinal purposes, especially for headache and eye trouble. In Ayurvedic medicine, it is used as aromatic, stimulant, carminative, and antispasmodic. It is also used for the treatment of epilepsy and hysteria. Powdered drug, mixed with sugar is used in urinary troubles. A decoction of the drug is reported to be given in Nepal to mother after parturition, probably as a sedative. *Valeriana jatamansi* syn. *Valeriana wallichi* (Bennet, 1987), popularly known as Indian Valerian (English), Mushkibala (Kashmiri) and Sughanthdawal or Tagar (Sanskrit) (Raina and Srivastava, 1992). The species is being labeled as critically endangered due to over-exploitation of rhizomes for its medicinal value, habitat degradation and other biotic interferences in its distribution ranges (www.nmpb.nic.in). Like many other non-timber forest products (NTFPs), this vulnerable plant is taken as forest gift and hence there is neither any control system in its harvest nor its domestication. Rhizome is an item of commerce and is being sold to different trading centre in the region. Although the economic value of the herb was reportedly unknown to the local people until recent past, the herb is now widely known for its market potential. Thus, the exploitation of this plant is increasing, leading to its rapid decline from its natural habitat in the Himalayan range. *Valariana jatamansi* inhabit diverse habitats of Darjeeling – Sikkim Himalaya, so it was thought worthwhile to undertake detailed studies on plant behaviour that enables the species to survive in these varied habitats. In some pockets of North Sikkim few species of this valuable medicinal plant observed. The species witnessed a tremendous decline in its population size due to its poor seed

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germination percentage (Sharma *et al*., 2005). It tells the tale of biotic interferences, which have brought it to the brink of extinction. If left as such for exploitation at the same rate, the species will disappear forever in near future. The survey revealed that, farmer's or inhabitants of different forest location, particularly in eastern Himalaya, they do not know how to improve its production, agronomic package and conservation. Our observation revealed that, date of planting (crop raised through seed) plays an important role in productivity of *Valeriana jatamansi*. Drastic reduction in yield of seed and rhizome has been recorded with the delay of sowing beyond optimum time May - July. Late sowing exposed the seedling to both the extreme of temperature. *i.e.,* low temperature during early growth period, which restrict the vegetative phase and high temperature during post vegetation phase of life cycle, which reduce the duration of rhizome and root development and consequently the crop yield (Mukherjee, 2009). Till date very little work has been conducted on this plant, particularly on enhancement of seed germination, proper agronomic manipulation for high yield *etc.* Keeping this aspect in mind, present work was undertaken to examine influence of various growth hormones on seed germination as well as planting time and crop configuration on growth habitats and economic production, of this high value rare medicinal plant of Darjeeling Himalaya. Statistical analysis of the data was done as per normal procedure (Gomez and Gomez, 1984).

MATERIALS AND METHODS

The experiment was carried out during April, 2009 to September, 2013 at Regional Research Station (Hill Zone), under Uttar Banga Krishi Viswavidyalaya, Kalimpong (1290 m asl). The soil of the experimental site was sandy loam having pH 5.1 with moderate available nitrogen, phosphorus and potassium (Table 1).

Mature seeds were collected from the Lava and Rishav (1800 m) area of Darjeeling hill. The fruits were collected during end of February, 2009 and March 2010, and kept in paper bags of convenient size after proper labelling. The fruits were shed dried in the open air and gently hand shaken while inside the paper bag. The minute clean seeds fall and settle in the bottom of paper bag. These fallen seeds were collected and stored in an open container. This process was repeated till the seeds were almost fully collected. This seed material was kept in desiccators with silica gel to avoid moisture absorption. During the investigation, seed were surface sterilized by dipping them in 0.5% aqueous solution of $HgCl_2$ for 2 minutes to remove bacterial and fungal contamination and then rinsed thoroughly (four times) with distilled water and then soaked in different concentration of growth regulators for 15 hr and place in a glass plate for dry. Viability test using 2,3,5, triphenyle tetrazolium chloride solution could not be performed in lab. The seeds were so small that the embryo could not be detached to observe the staining pattern. Hence seed germination was tested under field condition, 200 seeds are taken in triplicate and sown on beds with sieved and well sterilized (in autoclave) clay soil inside a polyhouse to test the germination. Sowing of seeds in a nursery bed was done under careful, on 15th and 21st April, respectively in 2009 and 2010. Meteorological data indicate that during these months day – night temperature of the experimental sites varied between 12 and 29^{0} C, probably meeting the optimum temperature requirement of this species and resulting in higher germination with less time for completion. Seed germination was tested under different hormonal treatments, *i.e.,* sterilized soil mixed with thiourea (0.1%), thiourea (0.2%), thiourea (0.3%), kinetin 50ppm, kinetin 100 ppm, kinetin 200 ppm, KNO_3 (0.1%), KNO_3 (0.2%) and KNO_3 (0.3%). Seed germination potential under different treatments was tested using randomized block design. Further, one field experiment was conducted with split plot design with five replication, having time of sowing in main plot, which included *viz*. first week of June (S1) and first week of July (S2) and three crop geometry pattern in subplots *viz.* 30 x 20 cm (P_1), 30 x 30 cm (P_2) and 30 x 45 cm (P_3). Irrigation and other recommended packages of practices were adopted during the crop growth period in both the years. Data on growth pattern was taken at 3 month intervals. The significant differences between the treatments were compared with the LSD at 5% level of probability (Gomez and Gomez, 1984).

Table 1: Physico-chemical status of the soil

pH	ECE (mho cm^{-1})	Available (kg ha^{-1}) N	P_2O_5	K_2O	Total N (%)	Organic C (%)	Organic matter (%)	C/N ratio
5.1	0.30	301	21.3	256	12.11	1.98	3.04	11.98

RESULT AND DISCUSSION

Seed germination study revealed significant improvement in germination percentage with kinetin and KNO_3 treatment compared to control (Table 2). Among the treatments, maximum seed germination was observed with KNO_3 (0.2%) (79.00±2.60), and it was significantly superior to rest of the hormonal treatments except kinetin 200 ppm. This recorded 138% more seed germination over the control. Thiourea (0.3%) took least time to start germination, and was *at par* with kinetin 200 ppm and KNO_3 (0.2%) treated seeds. However, days required for completion for germination was lesser with thiourea (0.3%) and was followed by KNO_3 (0.3%). 22-59 percent reduction was observed in germination with lower concentration of kinetin and KNO_3. Thiourea gave less percentage of seed germination compared to other growth regulator treatments as reported by (Nautiyal *et al*., 2001).

Transplanting of seedlings during the first week of June and July failed to produce any significant response on aerial biomass (g plant^{-1}) at 6 month and 9 month stage observations. However, it produced noteworthy response at later growth phases at 12, 15, 18, 21 and 24 month stage and produced significantly more fresh biomass with June transplanting (Table 3). Further, plant spacing gave considerable response at all the stages of observation, and utmost aerial biomass was recorded with spacing of 30 x 45 cm which was *at par* with 30 x 30 cm plant spacing at 6, 15, 18 and 21 month stage of observation. Moreover, at 24 month stage, significantly more fresh weight was recorded with the 30 x 45 cm spacing, and showed better response than other set of planting geometry. Least biomass was recorded with close spacing of seedlings. Underground biomass (g plant^{-1}) failed to produce any response to date of transplanting at 6, 9 and 15 month stage. However, it produced significant response at 12 and 18 month stage of observation (Table 4). Maximum underground biomass was recorded with June transplanting. Further, our study revealed that plant spacing produced significant response on underground biomass at all the stages of observation except 9 month stage. Maximum underground biomass was recorded with P_3 (30 x 45 cm) and it was *at par* with the spacing P_2(30 x 30 cm) at all stage of observation except at 6 month stage, and was statistically superior to P_3 (30 x 20 cm) spacing. Further, at 9 month stage spacing failed to produced any noteworthy response on fresh underground total biomass production.

Table 2: Effect of different hormonal treatments on seed germination of *Valeriana jatamansi* (Pooled)

Treatment	Germination (%)	Days required for onset of germination	Days required for completion of germination
Thiourea (0.1 %)	31.00±3.42	24.00	31.00
Thiourea (0.2 %)	60.11±2.63	18.33	22.33
Thiourea (0.3 %)	31.00±5.10	11.66	15.00
Kinetin $_{50}$	41.00±1.11	21.00	30.33
Kinetin$_{100}$	63.66±2.12	18.33	28.10
Kinetin$_{200}$	74.66±3.11	15.00	23.00
KNO_3 (0.1 %)	29.66±0.81	22.33	30.00
KNO_3 (0.2 %)	79.00±2.60	16.11	33.33
KNO_3 (0.3 %)	36.15±1.12	14.62	21.13
Control	33.13±1.32	29.33	43.66
Sem(±)	**2.19**	**1.58**	**1.98**
LSD (0.05)	**7.18**	**4.13**	**5.13**
CV (%)	**12.36**	**16.30**	**11.98**

Date of transplanting failed to produce any significant effect on fresh rhizome biomass at all the stage of observation, except at 9 month stage where July transplanting produced significantly higher rhizome biomass compared to June transplanting of seedlings (Table 5). However, maximum rhizome biomass was recorded with June planting seedlings except 9 month stage of data recording. Observations at 21 and 24 months revealed that significantly more rhizome weight was recorded with the June transplanting. Further, data revealed that plant spacing gave good response at all the stage of observation. Maximum rhizome biomass was recorded with 30 x 45 cm spacing, and was *at par* with 30 x 30 cm spacing at 12, 15, 18 and 21 month stages. This treatment was significantly superior to other tested spacing observation. Moreover, at 24 month stage, significantly more fresh weight was recorded with the 30 x 45 cm spacing, and showed better response than other set of planting geometry. Root biomass produced significant effect at all the stage of observation except 9 and 12 month (Table 6). Maximum root biomass was recorded with June transplanting, throughout the stage of observation, and showed significantly better response to other set of time. Plant spacing gave significant effect on root biomass at all stage of observation except at 12 month stage. More root growth was recorded with 30 x 45 cm and was statistically *at par* with the 30 x 30 cm spacing at 15, 18, 21 and 24 month stage of data recording, and significantly superior to closer spacing.

Table 3: Effect of time of transplanting and planting geometry on aerial biomass (g plant^{-1}) (Pooled)

Treatment	6 month	9 month	12 month	15 month	18 month	21 month	24 month
Transplanting time							
S_1 (June)	2.91	5.34	18.98	42.11	62.89	79.36	118.69
S_2 (July)	2.02	4.20	13.16	32.33	48.46	66.89	96.05
SEm(±)	**0.42**	**0.62**	**1.61**	**1.96**	**3.95**	**2.59**	**4.65**
LSD (0.05)	**NS**	**NS**	**4.50**	**5.68**	**11.77**	**7.84**	**17.08**
Plant spacing							
P_1 (30 × 20 cm)	2.09	3.89	12.33	33.00	51.14	71.06	89.26
P_2 (30 × 30 cm)	2.99	5.86	16.19	49.71	63.62	82.05	105.36
P_3 (30 × 45 cm)	4.07	7.03	26.42	52.66	68.30	86.39	111.03
SEm(±)	**0.43**	**1.11**	**2.38**	**2.71**	**5.11**	**3.11**	**1.63**
LSD (0.05)	**1.28**	**3.32**	**6.90**	**8.12**	**14.30**	**10.02**	**3.32**
CV (%)	**16.08**	**24.69**	**21.55**	**19.87**	**22.36**	**23.69**	**21.05**

Table 4: Effect of time of transplanting and planting geometry on underground biomass (g plant^{-1}) (Pooled)

Treatment	6 month	9 month	12 month	15 month	18 month	21 month	24 month
Transplanting time							
S_1 (June)	2.12	4.98	12.08	29.98	56.11	70.52	80.33
S_2 (July)	1.89	3.95	10.18	23.11	42.03	58.39	69.32
SEm(±)	**0.23**	**0.56**	**0.64**	**2.30**	**3.56**	**2.03**	**2.69**
LSD (0.05)	**NS**	**NS**	**1.90**	**NS**	**10.61**	**7.33**	**6.98**
Plant spacing							
P_1 (30 × 20 cm)	1.11	2.35	9.33	19.88	35.09	50.96	65.33
P_2 (30 × 30 cm)	1.29	3.17	12.66	25.21	48.26	75.36	70.23
P_3 (30 × 45 cm)	2.69	5.62	14.48	29.93	58.23	81.02	79.33
SEm(±)	**0.29**	**0.49**	**0.98**	**1.62**	**4.17**	**2.98**	**3.06**
LSD (0.05)	**0.85**	**NS**	**2.89**	**4.86**	**12.42**	**8.32**	**10.02**
CV(%)	**19.85**	**22.69**	**16.98**	**18.98**	**23.36**	**22.69**	**15.06**

Table 5: Effect of time of transplanting and planting geometry on rhizome biomass (g plant^{-1}) (Pooled)

Treatment	6 month	9 month	12 month	15 month	18 month	21 month	24 month
Transplanting time							
S_1 (June)	0.98	1.11	3.93	12.11	16.16	26.56	32.39
S_2 (July)	0.48	1.29	2.16	10.44	13.23	20.23	25.02
SEm(±)	**0.07**	**0.11**	**0.23**	**0.58**	**1.03**	**1.33**	**0.99**
LSD (0.05)	**NS**	**0.32**	**NS**	**NS**	**NS**	**4.89**	**2.89**
Plant spacing							
P_1 (30 × 20 cm)	0.47	1.97	2.64	7.00	12.11	18.97	22.36
P_2 (30 × 30 cm)	0.50	1.29	3.90	9.98	22.80	21.33	28.02
P_3 (30 × 45 cm)	0.87	2.67	3.92	10.92	25.14	26.35	33.36
Sem(±)	**0.10**	**0.17**	**0.11**	**0.80**	**3.01**	**2.69**	**1.31**
LSD (0.05)	**0.31**	**0.49**	**0.35**	**2.49**	**8.96**	**7.69**	**4.03**
CV(%)	**14.98**	**23.65**	**16.98**	**18.98**	**22.11**	**15.68**	**21.05**

Table 6: Effect of time of transplanting and planting geometry on root biomass (g plant^{-1}) (Pooled)

Treatment	6 month	9 month	12 month	15 month	18 month	21month	24 month
Transplanting time							
S_1 (June)	2.43	2.69	5.92	18.98	46.95	41.29	44.36
S_2 (July)	1.19	1.89	4.11	13.10	32.11	32.36	40.33
SEm(±)	**0.13**	**0.39**	**0.63**	**1.96**	**2.11**	**0.89**	**0.56**
LSD (0.05)	**0.38**	**NS**	**NS**	**5.82**	**6.28**	**2.89**	**2.03**
Plant spacing							
P_1 (30 × 20 cm)	0.87	0.98	3.11	10.23	21.12	28.32	39.31
P_2 (30 × 30 cm)	0.92	1.77	3.96	15.14	43.95	37.21	43.36
P_3 (30 × 45 cm)	2.69	3.04	4.98.	18.61	51.18	39.66	47.35
SEm(±)	**0.21**	**0.41**	**0.66**	**2.35**	**3.98**	**1.98**	**1.83**
LSD (0.05)	**0.61**	**1.21**	**NS**	**7.01**	**11.86**	**5.69**	**5.18**
CV (%)	**19.13**	**12.64**	**23.33**	**14.89**	**17.89**	**17.36**	**19.89**

Study revealed that, among various growth hormone treatments, maximum seed germination was observed with KNO_3 (0.2%). Optimum transplanting during the first week of June with spacing of 30 x 45 cm is best suited for Darjeeling condition for higher yield of the herb and economic production per unit area of land under crop raised through seed. This ultimately more beneficial to growers in turn higher net return.

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