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Growth and yield of ginger lily (*Hedychium spicatum* buch) as influenced by spacing

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ABSTRACT

A field experiment was conducted at Central Agricultural University, Imphal, Manipur during 2010 and 2011 to study the effect of spacing on the growth and yield of Hedychium spicatum, a valuable medicinal plant in temperate regions. Treatments comprised of four plant spacing: 30 × 20 cm, 30 × 30 cm, 30 × 40 cm and 40 × 40cm. Results showed that values on growth of H.spicatum were found to be highest in widest spacing of 40 × 40 cm (14.16 t ha^{-1}). Yield of the crop was higher even in 30 × 40cm spacing (13.46 t ha^{-1}) than the closer spaced distance 30 × 20 cm and 30 × 30 cm which gave 10.39 and 12.54 t ha^{-1} respectively. Though the number of rhizomes per unit area in closest spacing, 30 × 20 cm (32.61) outnumbered that of rhizomes per unit area in widest spacing, 40 × 40 cm (14.33), yield was observed to be highest in 40 × 40cm spacing which may be due to highest number of tillers plant^{-1} (3.41) and fresh weight of rhizomes plant^{-1} (109.61g) compared to lowest number of tillers plant^{-1} (2.54) and fresh weight of rhizomes plant^{-1} (68.08 g) in 30 × 20 cm spacing.

Keywords: Ginger lily, *Hedychium spicatum,* rhizomes, spacing

Hedychium spicatum Buch.-Ham (Ginger Lily) which belongs to Zingiberaceae family is found mainly in the forest or hills of Himalayan range without cultivation. The plants are found growing either in huge clumps or in sparse condition in the plains. The plant grows up to a height of around 1m-1.5 m bearing leaves which are oblong and reaches up to 30 cm or more. They bear terminal fragrant flowers in dense which are white in colour with an orange-yellow or red base having 15 to 25 cm long spikes. This plant has various medicinal properties. The rhizome extract has been reported to contain essential oil, starch, resins, organic acids, glycosides, albumen and saccharides, which has been advocated for blood purification and treatments of bronchitis, indigestion, eye disease and inflammations (Srimal *et al*., 1984 and Sravani *et al*., 2011). The plant rhizomes possess hypoglycaemic, vasodialator, spasmolytic, hypotensive, antioxidant and antimicrobial properties (Giri *et al*., 2010). Powdered rhizome of *H. spicatum* has been used clinically for the treatment of asthma (Chaturvedi and Sharma, 1975) and as anti-inflammatory and analgesic (Tandon *et al*., 1997). Rhizome powder is sprinkled as an antiseptic agent and also used in various aches and pains (Thakur *et al*., 1989). The essential oil can be used in perfumes, soaps, hair oils and in cosmetics. Locally rhizomes, are boiled and eaten with salt, powder of roasted rhizome is effective in asthma and respiratory disorders. The rhizome yields an aromatic volatile oil known as 'Kapur Kachri oil'.

Due to over exploitation and lack of management, this highly valuable species which has important role in Ayurvedic medicine as well as in perfumery industry, have reached near extinction. This plant has been reported to be amongst the high value targeted taxa during a series of plant explorations from 2007-2011 in the Darjeeling range of the Himalayas (Mukherjee, 2013) and hence major studies need to be taken up for its wide scale cultivation adopting scientific cultivation, among which maintaining good plant stand with optimum spacing distance is of great importance. Plant spacing is an important agronomic attribute since it is believed to have effects on light interception during which photosynthesis takes place which is the energy manufacturing medium using green parts of the plant. Good plant spacing gives the right plant density, which is the number of plants, allowed on a given unit of land for optimum yield (Obi, 1991). Studies have also indicated a positive linear relationship between seed spacing and root growth potential (South *et al*., 1990).

This study was taken up using organic means of cultivation with the objective of finding optimum plant spacing for obtaining economical yield, as the plant is rhizomatous which multiplies itself where appropriate spacing distance for the proper development of the plant is required.

MATERIALS AND METHODS

The present investigation was carried out at the Research Farm, Department of Agronomy, College of Agriculture, CAU, Imphal for two consecutive years, 2010 and 2011. The experimental farm is located at 24°442 latitude, 93°582 longitude and at an altitude of

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786 metres MSL with humid subtropical climate with cool, dry winters and warm and humid summer months. Temperature ranges from an average of 32°C in summer to near 4°C during winter months. Average annual rainfall is 1320 mm, with July being the wettest month. Seed rhizomes of *Hedychium spicatum* weighing about 50-55 g were planted in the month of June in the first year. At the end of the growing season, the rhizomes were harvested leaving the main mother shoot with primary rhizome to use for next season. The parameters were taken at the time of harvesting. The experiment was laid in Randomised Block Design with four treatments which consist of T_1: 30 ×20 cm, T_2: 30 × 30 cm, T_3: 30 × 40 cm and T_4: 40 ×40 cm and replicated five times. The size of the plot was 16 m^2 (4 × 4 m). The soil of the experimental field was clayey with soil available nitrogen and total phosphorus and potassium content of 466, 132 and 289 kg ha^{-1} respectively. At the final stage of field preparation FYM @ 25 t ha^{-1} were applied as basal. Weeding was done twice at 3 months and 7 months after planting. After the maturity of the crop, secondary tillers were counted leaving apart the main shoot for counting the number of tillers $plant^{-1}$. To observe the fresh weight of rhizomes, rhizomes were uprooted at the end of each growing season. These rhizomes were washed with running tap water to remove the soil adhered. Fresh weight of rhizomes was taken after removing rootlets.

Essential oil after harvesting of rhizome was extracted using Soxhlet ether extraction method (Anon, 1970). The data were subjected to statistical analysis appropriate to the design by following the procedure laid out by Gomez and Gomez, (1984).

RESULTS AND DISCUSSION

The plant height and number of leaves $plant^{-1}$ of *Hedychium spicatum* were not significant in both years. Though insignificant, higher values were recorded in the wider spaced plant.

Data showed that leaf length of *H. spicatum* was significantly influenced by different plant spacing. Among the treatments, the maximum leaf length (34.43 cm) was recorded in T_4 (40×40cm) which was *at par* with T_3 (30 ×40 cm) with 33.41 cm length followed by T_2 (30 ×30cm) with 31.87 cm long leaf. Lowest leaf length (30.70 cm) was recorded in T_1 (30 × 20cm). This finding was in line with the findings of Kiran *et al*. (2013) where the maximum leaf length was found in the widest spaced turmeric rhizome. Similar results were also shown by Rubio *et al.* (2003) who reported that shading effect of closed spaced neighbouring plant is the principal and significant factor of their competition and it had greatly affected the leaf development.

Spacing distance had significant effect on the number of tillers $plant^{-1}$. The maximum number of tillers per plant (3.41) was recorded in T_4 (40 × 40 cm) which was closely followed by T_3 (30 × 40cm) with 3.09 tillers $plant^{-1}$ but these were *at par*. This was then followed by T_2 with 2.68 tillers $plant^{-1}$. Lowest value was recorded in closely spaced distance of T_1 (30 × 20cm). The maximum number of tillers $plant^{-1}$ in wider spaced distance compared to the closer spacing may be attributed to better utilization of resources due to lesser competition between plant to plant. Singh *et al*. (2000); Gopichand *et al.* (2006) and Ali *et al.* (2010) also gave similar views and reported that plant spacing significantly increased the number of tillers $plant^{-1}$ in rhizomatous plants. This is also evident from the reports of NRCRJ (1982, 1983) which stated that the multiplication ratio was highest for the widest spacing ginger rhizomes.

With respect to the number of rhizomes m^{-2}, 30 × 20cm spacing gave significantly higher number of rhizomes m^{-2} followed by 30 × 30 cm. It is found that the lowest number of rhizomes m^{-2} was found in 40 × 40 cm spacing distance which was at par with 30 × 40 cm. The result is apparent from the spacing distance, as lesser spacing distance results in higher plant population per unit area compared to increasing spacing distance. Higher plant population resulted in more number of rhizomes m^{-2}.

Spacing distance had significant effect on fresh weight of *H. spicatum*. Highest fresh weight (109.61 g) of rhizomes $plant^{-1}$ was recorded in T_4 (40 × 40cm) followed by T_3 (30 × 30 cm). Lowest fresh weight (68.06 g) was recorded in T_1 (30 × 20cm). Pratap and Singh (2007) and Kiran *et al.* (2013) also stated that fresh weight of rhizomes $plant^{-1}$ increased with wider spacing in rhizome crops. This might be due to the larger rhizomes that have been formed under wide spaced crop. Moreover, availability of more nutrients per plant might have contributed towards its higher weight of rhizomes.

In the oil content context of *Hedychium spicatum*, it is found that in the first year, the oil content of the crop in the first year was found to be insignificant. While in the second year trial, the oil content of the crop was found to be significant where the highest was found in the widest spaced distance of 40 × 40 cm which was *at par* with the oil content in the crops grown under 30 × 40 cm and 30 ×

30 cm spacing distance. The lowest oil content was found in the 30 × 20 cm spacing. This result might be due to the relation of higher level of nutrient absorption plant^{-1} in widely spaced crop compared to lower availability of nutrients in closely spaced crops due to higher plant population.

The yield data revealed significant effect of different plant spacing on yield of *H.spicatum*. It may be noted that the highest yield (t ha^{-1}) was obtained widest spaced distance, 40 × 40 cm recording 14.16 t ha^{-1} which was at par with rhizome yield obtained in 30 × 40 cm spacing distance. This was then followed by yield obtained in 30 × 30 cm spacing. The lowest yield was obtained in the closely spaced distance (30 × 20 cm) which recorded 10. 39 t ha^{-1}. This is apparent from the fact that the yield of rhizomes is correlated with number and size of leaves and tillers plant^{-1} and weight of tillers as reported by Roy and Wamanan (1990). At closer spacing, the yield and yield contributing factors were lower due to competition between plants for nutrients, sunlight, fertilizer and water etc. which resulted in least rhizome yield. (Rashid *et al*., 1996; Bahadur *et al*., 2000; Carvalho *et al*., 2001) also found higher rhizome yield of turmeric fresh yield with wider spacing. This may be due to the utilisation of growth resources efficiently as there was lesser plant competition. The larger underground spaces available under widely spaced distance allowed crop to grow well without much restriction from neighbouring rhizomes.

From the present study, it may be concluded that wider spaced distance in the cultivation of *Hedychium spicatum* resulted in better performance regarding growth attributes as well as higher yield. Even though, the number of rhizomes m^{-2} in closely spaced distance outnumbered that of wider spaced distance, the yield cannot come up satisfactory due to small rhizomes with lesser weights. Thus, adopting wider spaced distance of

Table 1: Effect of spacing on plant height, number of leaves and leaf length.

	Plant height (cm)			No. of leaves plant^{-1}			Leaf length (cm)		
Treatment	**2010-2011**	**2011-2012**	**Pooled**	**2010-2011**	**2011-2012**	**Pooled**	**2010-2011**	**2011-2012**	**Pooled**
T_1 (30x20)	130.47	151.23	140.85	12.53	15.70	14.11	29.89	31.50	30.70
T_2	131.87	152.83	142.35	12.80	16.93	14.87	31.05	32.68	31.87
T_3	133.75	152.93	143.34	12.65	17.08	14.87	32.83	33.98	33.41
T_4	135.05	155.45	145.25	13.10	17.18	15.14	33.70	35.16	34.43
S.Em(±)	**2.40**	**3.74**	**2.22**	**0.48**	**0.56**	**0.37**	**0.85**	**0.68**	**0.55**
LSD (0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**2.63**	**2.11**	**1.60**

Table 2: Effect of spacing on number of tillers, rhizomes and fresh weight of rhizomes.

	No. of tillers plant^{-1}			No. of rhizomes (m^{-2})			Fresh weight of rhizomes plant^{-1} (g)		
Treatment	**2010-2011**	**2011-2012**	**Pooled**	**2010-2011**	**2011-2012**	**Pooled**	**2010-2011**	**2011-2012**	**Pooled**
T_1	1.86	3.21	2.54	31.22	33.99	32.61	53.69	82.47	68.08
T_2	2.08	3.28	2.68	24.57	27.07	25.82	68.99	112.58	90.78
T_3	2.49	3.70	3.09	15.31	21.29	18.30	76.79	120.95	98.87
T_4	2.83	3.99	3.41	13.45	15.21	14.33	87.79	131.42	109.61
S.Em(±)	**0.21**	**0.11**	**0.12**	**3.64**	**2.17**	**2.12**	**2.93**	**6.58**	**3.60**
LSD (0.05)	**0.65**	**0.34**	**0.35**	**11.20**	**6.67**	**6.18**	**9.03**	**20.27**	**10.51**

Table 3: Effect of spacing on oil content and yield of rhizomes.

Treatment	**Oil content of rhizome (%)**			**Yield of rhizomes (t ha^{-1})**		
	2010-2011	**2011-2012**	**Pooled**	**2010-2011**	**2011-2012**	**Pooled**
T_1	3.10	3.18	3.14	9.33	11.44	10.39
T_2	3.26	3.30	3.28	11.34	13.74	12.54
T_3	3.39	3.49	3.44	12.22	14.70	13.46
T_4	3.43	3.55	3.49	12.68	15.65	14.16
S.Em(±)	**0.13**	**0.08**	**0.08**	**0.46**	**0.64**	**0.40**
LSD (0.05)	**NS**	**0.25**	**0.23**	**1.43**	**1.98**	**1.16**

Note: *T_1: 30 ×20cm, T_2: 30 × 30 cm, T_3: 30 × 40 cm and T_4: 40 ×40 cm*

40 × 40 cm in *Hedychium spicatum* cultivation can result in higher yield with lesser number of plantlets which can even be more profitable from economic point of view.

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