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Biennial harvest reduces rhizome multiplication rate and provides no yield advantage in ginger (*Zingiber officinale* Roscoe.)

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Abstract

A study was conducted during 2009–10 and 2010–11 under rainfed condition to observe the sprout emergence, tiller production and yield when the ginger was allowed to grow in the second season/year without harvest in first year/season. First generation ginger was not harvested and allowed to emerge on the same container and harvested in subsequent year in second generation in the month of January 2011. After harvesting, fresh rhizome was cleaned and sorted into first year produce and second year produce based on their appearance and texture and weighed separately, their proportion was estimated and multiplication rate from first generation crop to second generation crop was calculated. The mean shoot emergence and tiller production were five and 19, respectively. Average yield in first, second years and total yield were 209, 566 and 775 g plant^{-1}, respectively. The share between first and second year yield were 27.8 and 72.2%, respectively and mean multiplication rate was 3.5 times. Although, yield levels tend to increase in second season, the multiplication rate was much reduced. Hence, the practice of biennial harvest may not have clear yield advantage over regular annual harvest.

Keywords: biennial, emergence, ginger, multiplication rate, shoot, tiller, yield, *Zingiber officinale*

Ginger (*Zingiber officinale* Roscoe.) - a well known spice used as a taste-maker, flavourant, appetizer and in drugs, in fresh, dried or powdered form. It is an annual crop with duration of 8 to 10 months. However, crop is harvested between six and twelve months after planting depending on the product for which the rhizomes are used, price trend in the market and climatic conditions (Kandiannan *et al*. 1996). When rhizome is used for vegetable or for preparation of ginger preserve, candy, soft drinks, pickles and alcoholic beverages, harvesting should be done early, whereas, when it is used for dried ginger and preparation of value added products like ginger oil, oleoresin, dehydrated and bleached ginger, harvesting should be done late. In India, early harvest at 200-215 days after planting (DAP) gave higher yield than late harvest at 230-245 DAP (Aiyadurai 1966), whereas, in Australia, early harvest yielded 50 t ha^{-1} and late harvest 90-100 tha^{-1} (Lee *et al*. 1981). Smith (2004) has reported that early harvest ginger (6 months after planting (MAP) produced 12 to 50 t ha^{-1}

with an average of 30 t ha^{-1}, first late harvest (eight MAP) gave 20 to 50 t ha^{-1} with a mean of 35 t ha^{-1} and second late harvest (10 – 12 MAP) yield 38 to 75 t ha^{-1} with a mean of 45 t ha^{-1} in Australia. However, Nair & Varma (1970) and Pawar & Patil (1987) have observed no differences in yield when ginger was harvested 215 to 275 days after planting (DAP). Due to low market price for ginger in some years, farmers leave the crop without harvest and allow it to grow as such in the second year/ season and then first and second year rhizome together are harvested. Since, there is no experimental evidence to show such harvest would give yield advantage; the present study was undertaken with an objective to observe the sprout emergence, tiller production and yield when the ginger was allowed to grow in the second season/year without harvesting during the first year/season.

Experiment was conducted at Experimental Farm, ICAR-Indian Institute of Spices Research, Peruvannamuzhi, Kozhikode District, Kerala (geographical coordinates 11°.342 N, 75°.482 E and 60 m MSL) during 2009–10 and 2010–11. Ginger was planted during May 2009 in cement tubs having 45 cm height with 45 cm diameter filled with potting mixture (60 kg) containing soil: sand: FYM at 2:1:1 ratio. The tubs were kept in open net house (green shade net, 50%) and crop was grown as rainfed. Annual rainfall (January to December) received during 2009 and 2010 was 5420 mm and 4121 mm, respectively. First generation ginger was not harvested and allowed to emerge on the same container and harvested in subsequent year in second generation in the month of January 2011. At the beginning of the second season the container was filled with additional potting mixture. The observations *viz*., number of shoots emergence, number of tillers and fresh rhizome yield per clump in the second crop from 600, 300 and 150 plants, respectively were recorded. Data were scrutinized and only 512, 242 and 112 observations were retained in each case, respectively, with these data, frequency distribution was calculated. The number of frequency classes was identified based on Yule's formula $2.5 \times n^{1/4}$ where, 'n' is the total number of observations. The class-intervals was found out by using the relationship C = (Maximum value in the data set - minimum value in the data set) / Number of classes (Rangaswamy 1995). After harvesting, fresh rhizome was cleaned and sorted into first year produce and second year produce based on their appearance and texture and weighed separately, their proportion was estimated and multiplication rate from first generation crop to second generation crop was also calculated.

The results indicated that on an average, five new sprouts emerged from first season un-harvested clump with a range of two to fourteen having coefficient of variation (CV) of 41.03% (Table 1). Maximum plants (19.7%) produced four shoots followed by five shoots (19.5% plants) (Fig. 1a). Ginger has a subterranean stem (rhizome) modified for the vegetative propagation and storage of food materials. The stem has nodes with scale leaves and internodes. Except for the first few nodes, all the nodes have axillary buds. When the rhizome bit is used for planting (seed rhizome or setts), there may be one or more apical buds on it; however, normally only one bud becomes active. When large seed pieces are used, more than one bud may develop into shoot simultaneously (Ravindran *et al*. 2005). The mean number of tiller $plant^{-1}$ in second season crop was nineteen with a range of three to 46 and having CV of 40.21% (Table 1). Maximum plants (28.9%) produced 16–20 tillers followed by 21–25 tillers from 20.2% plants (Fig. 1b). Sasikumar *et al*. (1992) have reported that mean tiller production was 16.8 with a range of 2.7–35.5 having CV of 45.9% (CV was maximum compared to other traits studied by them) from first generation crop. Kandiannan *et al*. (2012) found that tiller production was in the range of 2.0–21.0 with a mean of 10.7 and a CV of 32.7% and distribution pattern of tillers indicated that majority of plants (49%) produced 6-10 tillers in first generation crop.

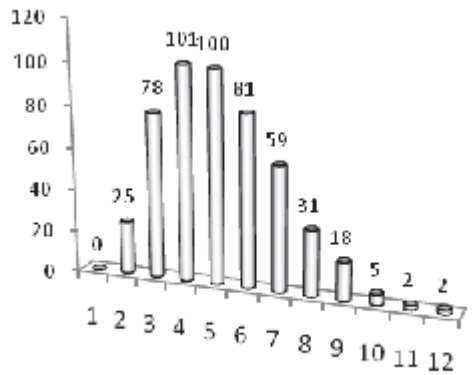
Mean first and second year yields and total yield were 209, 566 and 775 g $plant^{-1}$, respectively

(Table 1). Maximum plants (28.5%) were recorded a yield level of 226 – 300 g plant^{-1} from first year produced rhizome (Fig. 1c). Sasikumar *et al*. (1992) have reported a mean yield of 363.1 g plant^{-1} with a range of 55.0–770.0 g plant^{-1} with 39.3% CV in first season crop. In another study, Kandiannan *et al*. (2012) has observed that fresh rhizome yield per plant ranged from 78.0–575.0 g plant^{-1}and frequency distribution indicated that maximum plants (27%) were in a yield level of 251-300 g plant^{-1}. The second year rhizome yield indicated that maximum plants of 24.1% yielded 451–600 g plant^{-1} (Fig. 1d). Maximum plants (25.9%) yielded in the range of 681–850 g plant^{-1} (Fig. 1e) for total fresh rhizome yield (first and second year yield put togather). The proportional share of first year yield is in the range of 6.7–79.8% with a mean of 27.8% and having CV of 44.4% (Table 1) and maximum plants (30.4%) contributed in the range of 11–20% for total rhizome yield. The share of second year yield was between 20.2 and 93.3% with a mean of 72.2% and a CV of 17.1% and maximum plants (29.5%) are with a share of 61–70%.

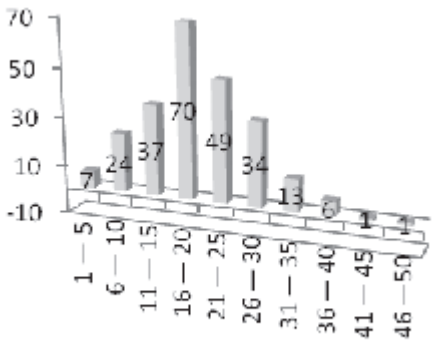
Multiplication from first season to second season indicated that rhizomes on an average multiplied 3.5 times with a range of 0.3–14.0 with a CV of 69.8% (Table 1). Out of 112 plants, rhizomes of 40.2% of plants are grown 2.1–4.0 times (Fig. 1f). Sasikumar *et al*. (2003) has reported a multiplication rate of 9.3 to 11.0 in first generation crop. Kandiannan *et al*. (2012) has noted that yield multiplication rate ranged from 2.2 to 26.1 with a mean of 9.6. Maximum number of seed (47.5%) multiplied 6-10 times followed by 22.5% in the range of 1–5 times. The remaining 12.5%, 10.0%, 5.0% and 2.5% took a multiplication in the range of 11–15, 16–20, 21–25 and 26–30 times and it was found that rate of multiplication was higher with smaller seed size and lesser with bigger seed sett. Similar observation also reported by Okwuowulu (1994) from Nigeria. Although, yield levels tend to increase in second season, the multiplication rate was much reduced. Hence, the practice of biennial harvest may not have clear yield advantage over regular harvest.

Table 1. Growth and yield parameters in the second year crop of ginger

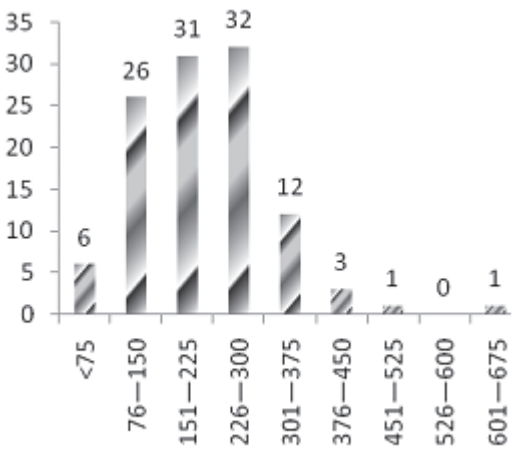
Statistics	Sproutsemerged clump^{-1} in second generation	Tillers plant^{-1} in second generation	Fresh rhizome yield g plant^{-1}			Proportion of yield (%)		Multiplication rate(1st to 2nd year yield)
			First year	Second year	Total	1st year	2nd year	
Count	512	242	112	112	112	112	112	112
Mean	5	19	209	566	775	27.8	72.2	3.5
Maximum	14	46	650	1267	1517	79.8	93.3	14.0
Minimum	2	3	33	43	192	6.7	20.2	0.3
SD±	2.02	7.78	102.4	217.5	252.6	12.4	12.4	2.4
CV (%)	41.03	40.21	49.0	38.4	32.6	44.4	17.1	69.8



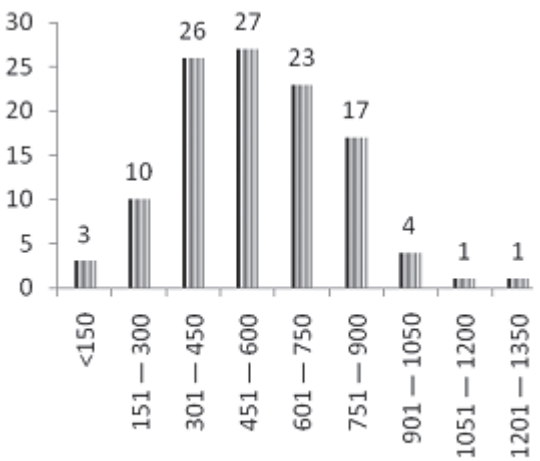
(A) Emergence of sprouts in second season



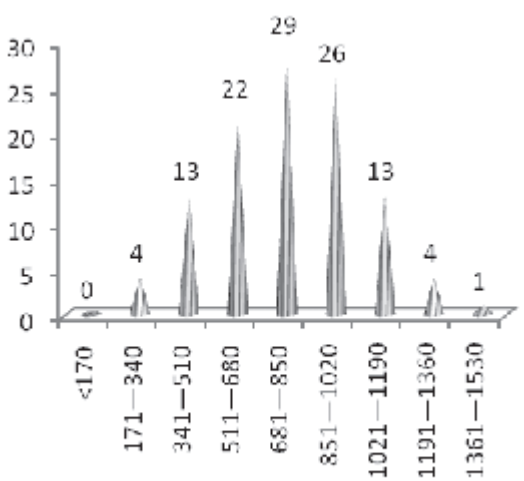
(B) Tillers per plant in second season



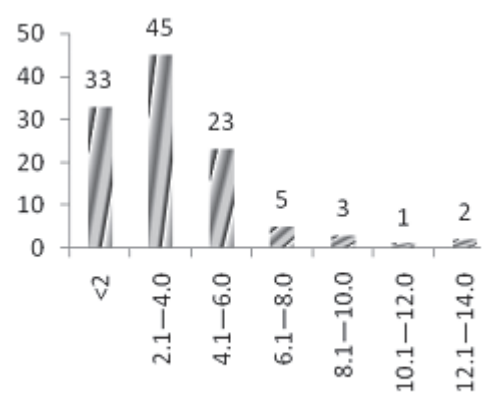
(C) First season yield per plant (g)



(D) Second season yield per plant (g)



(E) Total yield per plant (g)



(F) Multiplication ratio first to second season

Fig. 1. Growth, yield and multiplication rate of biennial grown ginger

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