Journal of Crop and Weed 8(1): 17-21 (2012)

Study of growth, yield and quality of organically grown ginger varieties under rainfed condition of Manipur

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Received: 17.03.2012, Revised: 12.04.2012, Accepted : 26.05.2012

ABSTRACT

A field experiment on ginger (Zingiber officinale Rosc.) was conducted at the Horticulture Experimental Farm, College of Agriculture, Central Agricultural University, Imphal during 2007 and 2008 to study the growth and productivity of four varieties viz., Manipur local, Bhaisey, Gorubathan and Nadia. Among the varieties, Bhaisey showed earliness in sprouting, produced taller plants, recorded greater number of tillers per clump, higher canopy spread, leaf area index, dry matter accumulation, crop growth rate, rhizome bulking rate and yield than those of Nadia and Manipur local; and were closely followed by Gorubathan. The highest rhizome yield (20.46 t ha^{-1}) was produced by Bhaisey followed by Gorubathan (19.13 t ha^{-1}). Bhaisey also produced good quality rhizome having high specific gravity (1.25 g cc^{-1}), dry matter (20.4%), oleoresin content (5.12%) and moderately low crude fiber content (5.71%). Dry matter content in rhizome showed positive relationship with specific gravity and oleoresin content; but crude fibre content was negatively related with dry matter and oleoresin content. The results suggest growing of Bhaisey for producing higher yield with good quality of ginger at Manipur.

Key words: Organic farming, yield, *Zingiber officinale*

Spices are high value and export oriented crops, which play an important role in agricultural economy of the country. Among the spices, ginger (*Zingiber officinale* Rosc.) is the main cash crop supporting the livelihood and improving the economic level of many ginger growers of North-Eastern Region. The soil, climate and other ecological factors of this region favour the growth and development of the crop and there is scope to increase the productivity of this crop in North-Eastern Region. In Manipur, it is cultivated over an area of 2.14 thousand hectare providing 3.53 thousand tonnes of annual production with an average productivity of 1.65 t ha^{-1}. It is quite below the national average productivity (3.5 t ha^{-1}). The main reasons for low productivity are non availability of good quality high yielding promising variety and no use of agrochemicals. The ginger production in the north eastern region is organic by default because the farmers of the region neither apply chemical fertilizers nor chemical pesticides. They are applying only the locally available farmyard manures (cow dung manure, pig manure, poultry manure or rabbit manure). It produces low yield but of high quality that has high demand in the world's market. Keeping this idea in view and considering the importance of the problems, an effort has been made to study the performance of ginger varieties grown organically.

MATERIALS AND METHODS

The field experiment was conducted during 2007 and 2008 at the Horticulture Experimental Farm, College of Agriculture, Central Agricultural University, Imphal, Manipur. The place is located at 24° 45' N latitude, 93° 56' E longitude with an altitude of 790 m above MSL. The experimental soil was clayey in texture (15.5% sand, 21.2% silt and 61.1% clay), medium-high in fertility status (330, 13.3 and 327 kg ha^{-1} available N, P and K respectively), well-drained with gentle slope. The experimental site comes under warm humid moist region where monsoon normally starts from April and extends up to September. The experiment was laid out in randomized block design with four varieties (*Manipur local*, *Bhaisey*, *Gorubathan* and *Nadia*) in five replications. The rhizomes (20g) were planted in the fourth week March during both the years with a spacing of 30 cm x 30 cm in 3.6 x 3.0 m plots. A general dose of 10 t FYM ha^{-1} was applied during land preparation. No chemical fertilizer was applied. The crop received good amount of rainfall in the months of April to October in 2007; whereas, in 2008, good rainfall occurred only in four months (June-September). The observations on morphological data were recorded randomly from ten plants of each plot. But plant samplings for growth studies were made at different growth stages from three plants within the earmarked area of each plot. The crop was harvested at 8 months after planting when the leaves turn yellow and start drying up. The clumps were lifted carefully with the help of a spade and the rhizomes were separated, dried in shade for 2-3 days and weights were recorded.

RESULTS AND DISCUSSION

Growth attributes

The variety *Bhaisey* took minimum time (58.7-59.7 days) to sprout followed by *Gorubathan*, *Nada* and *Manipur local* (61.8-62.5 days). The crop variety exhibited significant response on plant height and number of tillers per clump. *Bhaisey* produced the taller plants with higher number of tillers per clump than others. *Gorubathan* showed plants of intermediate height with medium number of tillers per clump. *Manipur local* produced smallest plants with

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lowest number of tillers per clump and at par with *Nadia* in both the years (Table 1 and 2).

The highest values of canopy spread and LAI were recorded in *Bhaisey* and were markedly higher than those of *Manipur local* at all the growth stages and that of *Nadia* at early growth stages during both the years (Table 3 and 4). *Gorubathan* recorded intermediate spread of canopy and LAI sowing its superiority over *Nadia* and *Manipur local* at early stage. *Manipur local* exhibited lower values of canopy spread and LAI as compare to the other varieties.

Table 1: Effect of variety on sprouting and height of the plant (cm) at different stages

Variety	Sprouting time (days)		Height of plants (cm)					
			2007			2008		
	2007	2008	90 DAP	150 DAP	210 DAP	90 DAP	150 DAP	210 DAP
Manipur local	61.8	62.5	31.0	62.2	63.3	32.3	62.4	64.1
Bhaisey	58.7	59.7	36.4	66.3	67.9	35.6	67.5	69.2
Gorubathan	59.9	60.7	34.5	64.8	66.1	34.5	65.6	67.8
Nadia	61.1	62.0	32.8	63.2	65.2	33.0	63.7	66.2
SEm (±)	**0.99**	**1.20**	**1.10**	**0.95**	**0.98**	**0.76**	**1.14**	**1.10**
LSD (0.05)	**3.05**	**NS**	**3.40**	**2.92**	**3.01**	**2.33**	**3.51**	**3.40**
CV (%)	**3.70**	**4.40**	**7.60**	**3.31**	**3.33**	**5.00**	**3.90**	**3.70**

Table 2: Effect of variety on number of shoots per clump

Variety	Number of tillers clump^{-1}					
	2007			2008		
	90 DAP	150 DAP	210 DAP	90 DAP	150 DAP	210 DAP
Manipur local	1.9	5.5	6.7	1.9	5.4	6.7
Bhaisey	2.2	6.2	7.5	2.3	6.0	7.4
Gorubathan	2.1	5.9	7.3	2.1	5.7	7.2
Nadia	2.0	5.6	6.9	2.0	5.5	6.9
SEm (±)	**0.06**	**0.16**	**0.16**	**0.08**	**0.13**	**0.14**
LSD (0.05)	**0.19**	**0.50**	**0.48**	**0.24**	**0.41**	**0.42**
CV (%)	**6.90**	**6.20**	**4.95**	**8.20**	**5.30**	**4.30**

Table 3: Effect of variety on canopy spread of ginger clump

Variety	Canopy spread (cm^{-2} clump^{-1})					
	2007			2008		
	90 DAP	150 DAP	210 DAP	90 DAP	150 DAP	210 DAP
Manipur local	523	1546	2079	526	1514	2089
Bhaisey	667	1717	2222	643	1695	2208
Gorubathan	629	1643	2172	610	1619	2165
Nadia	567	1597	2123	565	1569	2119
SEm (±)	**16.0**	**34.5**	**32.4**	**13.6**	**36.2**	**36.5**
LSD (0.05)	**49.4**	**106.3**	**99.9**	**42.0**	**111.5**	**112.3**
CV (%)	**6.0**	**4.7**	**3.4**	**5.2**	**5.1**	**3.8**

Note: DAP= Days after planting

Table 4: Effect of variety on leaf area index of ginger

Variety	Leaf area index					
	2007			2008		
	90 DAP	150 DAP	210 DAP	90 DAP	150 DAP	210 DAP
Manipur local	0.25	2.17	2.38	0.25	2.34	2.51
Bhaisey	0.35	2.56	2.75	0.34	2.72	3.03
Gorubathan	0.31	2.41	2.66	0.32	2.60	2.89
Nadia	0.27	2.30	2.55	0.28	2.51	2.68
SEm (±)	**0.01**	**0.06**	**0.06**	**0.01**	**0.07**	**0.07**
LSD (0.05)	**0.04**	**0.17**	**0.19**	**0.03**	**0.21**	**0.22**
CV (%)	**9.60**	**5.20**	**5.50**	**7.20**	**6.10**	**5.60**

Note: DAP= Days after planting

The dry matter accumulation differed greatly among varieties in most of the stages during both the years. *Bhaisey* produced maximum dry matter yield followed by *Gorubathan* at all the stages in both the years. *Manipur local* produced the lowest dry matter yield and was comparable to that of *Nadia* (Table 5). The crop growth rate (CGR) varied only at early period (90-150 DAP) between the varieties and *Bhaisey* produced the highest CGR and was closely followed by *Gorubathan*, but greatly higher than that of *Manipur local* during both the years (Table 6). *Manipur local* recorded the lowest CGR but was at par with *Nadia*. Early sprouting might help *Bhaisey* in boosting up its initial growth and thereby improving its growth parameters like plant height, number of tillers per clump, canopy spread, LAI, dry matter accumulation and CGR over other varieties. Similar inter-varietal differences in growth pattern of ginger were also observed by Angom (2000) and Tiwari (2003).

Crop productivity and quality

The rhizome bulking rate during the initial period (90-150 DAP) varied significantly among the varieties (Table 7). *Bhaisey* recorded maximum rhizome bulking rate (24.7 and 24.1 g m^{-2} day^{-1} in 2007 and 2008 respectively) at early period and ultimately produced the highest rhizome yield (20.51 and 20.41 t ha^{-1}) that closely followed by *Gorubathan* (18.92 and 19.33 t ha^{-1}). *Manipur local* produced the lowest rhizome yield (16.45 and 17.23 t ha^{-1}). The variety *Nadia* also produced poor yield (18.14 and 18.31 t ha^{-1}). Pooled analysis of two years data also followed a same trend. The results are in conformity with the findings of Bhutia (1997) and Yadav *et al.* (2004).

Table 5: Effect of variety on dry matter accumulation in ginger

Variety	Dry matter accumulation (g m^{-2})					
	2007			2008		
	90 DAP	150 DAP	210 DAP	90 DAP	150 DAP	210 DAP
Manipur local	132	494	602	123	482	583
Bhaisey	153	568	681	146	565	667
Gorubathan	145	542	649	138	526	634
Nadia	137	510	622	129	500	610
SEm (±)	**3.0**	**11.7**	**14.8**	**4.7**	**12.9**	**14.0**
LSD (0.05)	**9.3**	**36.2**	**45.7**	**14.5**	**39.6**	**43.3**
CV (%)	**4.7**	**5.0**	**5.2**	**7.8**	**5.4**	**5.3**

Note: DAP= Days after planting

Table 6: Effect of variety on crop growth rate in ginger

Variety	Crop growth rate (g m^{-2} day^{-1})			
	2007		2008	
	90-150 DAP	150-210 DAP	90-150 DAP	150-210 DAP
Manipur local	6.04	1.90	5.96	1.86
Bhaisey	6.91	1.89	6.88	1.69
Gorubathan	6.61	1.70	6.57	1.64
Nadia	6.22	1.85	6.18	1.83
SEm (±)	**0.13**	**0.08**	**0.15**	**0.07**
LSD (0.05)	**0.41**	**NS**	**0.45**	**NS**
CV (%)	**4.70**	**9.70**	**5.10**	**9.40**

The quality parameters like specific gravity did not vary, but dry matter, oleoresin and crude fibre content in rhizome varied significantly among the varieties (Table 7). The highest dry matter content (20.4%) in rhizome was recorded in *Bhaisey* followed by *Gorubathan* (19.7%). *Bhaisey* had higher oleoresin content (5.12%) in rhizome as compared to *Manipur local* (4.28%) but followed by *Gorubathan* (4.88%) and *Nadia* (4.61%). *Nadia* contained the lowest crude fibre in its rhizomes (5.17%) and was followed by *Bhaisey* (5.71%). High quality rhizome (grade I) should have 22% dry matter, 5% oleoresin, and 8% or less crude fibre (Anon., 2004). *Bhaisey* and *Gorubathan* showed superiority over other varieties in respect of higher dry matter and oleoresin content and lower crude fibre content in rhizome than other varieties in this investigation. *Nadia* though contained the lowest crude fibre in its rhizomes (5.17%) but it also had less dry matter and oleoresin content, thus, reducing its quality. It is interesting to note that the quality parameters of rhizome are positively or negatively related to each other.

Table 7: Effect of variety on rhizome bulking rate and rhizome yield

Variety	Rhizome bulking rate (g m^{-2} day^{-1})				Rhizome yield (t ha^{-1})		
	2007		2008		2007	2008	Pooled
	90-150*	150-210	90-150	150-210			
Manipur local	20.7	9.25	20.9	9.32	16.45	17.23	16.84
Bhaisey	24.7	8.94	24.1	9.01	20.51	20.41	20.46
Gorubathan	22.1	9.25	21.8	9.38	18.92	19.33	19.13
Nadia	20.9	9.47	21.5	8.93	18.14	18.31	18.23
SEm (±)	**0.68**	**0.27**	**0.66**	**0.31**	**0.72**	**0.65**	**0.69**
LSD (0.05)	**2.11**	**NS**	**2.03**	**NS**	**2.22**	**1.99**	**2.11**
C V (%)	**6.90**	**6.60**	**6.70**	**7.50**	**8.70**	**7.70**	**8.20**

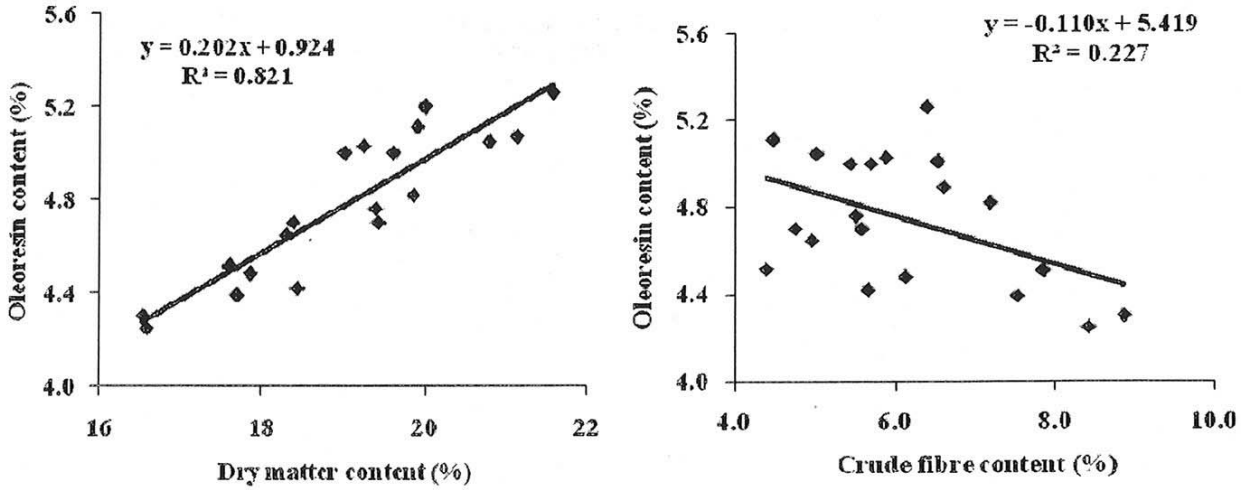
*Note: *DAP= Days after planting*

Table 8: Effect of variety on rhizome quality

Variety	Specific gravity (g cc^{-1})		Dry matter (%)		*Oleoresin	*Crude fibre
	2007	2008	2007	2008	(%)	(%)
Manipur local	1.23	1.20	17.6	17.2	4.28	7.68
Bhaisey	1.27	1.24	20.5	20.3	5.12	5.71
Gorubathan	1.26	1.22	19.8	19.5	4.88	6.17
Nadia	1.24	1.20	18.4	18.1	4.61	5.17
SEm (±)	**0.02**	**0.02**	**0.46**	**0.53**	**0.23**	**0.29**
LSD (0.05)	**NS**	**NS**	**1.42**	**1.62**	**0.72**	**0.89**
CV (%)	**3.10**	**4.40**	**2.40**	**2.70**	**2.40**	**2.60**

*Note: *Oleoresin and crude fibre content in rhizome were estimated in 2008*

The dry matter content was positively correlated with specific gravity and oleoresin content indicating their compatibility in improving rhizome quality. Again it was noticed that crude fibre content negatively related with dry matter and oleoresin contents (Fig.1). This has a good impact on quality control. If dry matter and oleoresin contents increase, the crude fibre content must decrease. Thus, *Bhaisey* having high dry matter and oleoresin contents recorded the low crude fibre content and improved its rhizome quality as compare to other varieties. The difference in quality parameters might be due to the inherent characters of the varieties (Borthakur, 1992; Yadav *et al.*, 2004).



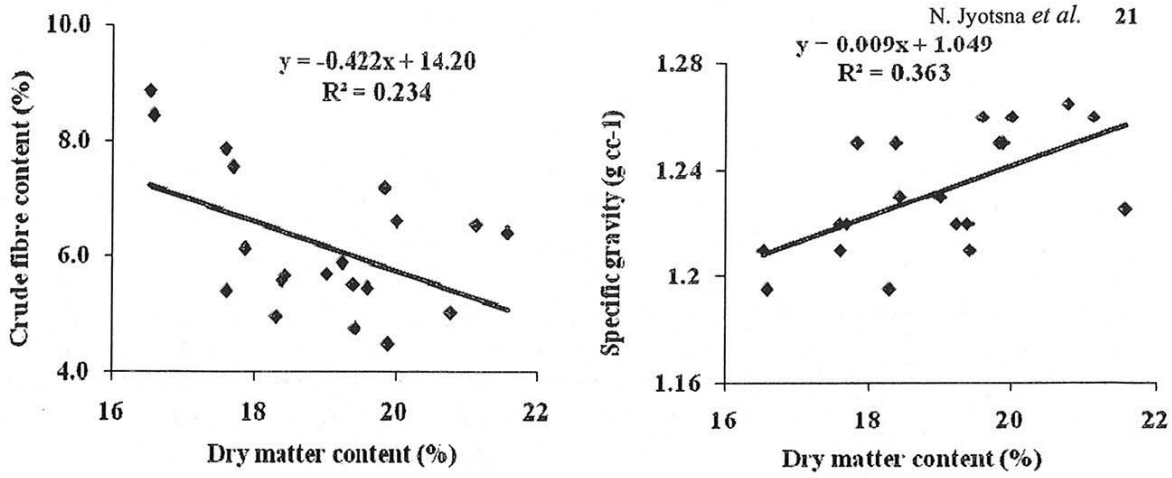


Fig. 1: Relationships between different quality parameters

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