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Response of ginger (*Zingiber officinale*) to methods of planting and levels of phosphorus in a rehabilitated forest developed on sodic land

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Abstract

Experiments were conducted during 1999 and 2000 at Banthra Research Station of NBRI, Lucknow (UP) to standardize agro-techniques of ginger cultivation in forest gaps. The response of three methods of planting and three levels of phosphorus was studied, which revealed that the flat bed followed by earthing and application of P_2O_5 50 kg ha^{-1} recorded the maximum growth and yield (7.88 t ha^{-1}). These treatments also influenced the bio-chemical composition positively showing greatest values of crude protein (9%), crude fibre (5.15%) and volatile oil (1.45%). The study showed a modest potential of ginger cultivation in a semi-reclaimed sodic soils through afforestations.

Key words: crop yield, fibre content, ginger, phosphorus, sodic soils, *Zingiber officinale*

Ginger *(Zingiber officinale* Rosc.), a perennial herb usually grown as annul crop, is a major spice in India. Indian ginger has high esteem in global market because of its characteristic lemon like flavour. The crop exhibited an annual growth rate of 4.6% in area, 7.4% in production and 2.7% in productivity. It was cultivated on 83,940 ha in the country with a gross national production of 2,82,720 tonnes and productivity 3.4 t ha^{-1} during 2000-2001 (Peter & Nybe 2002). Ginger shared 1.5% of spices exported from India and has earned Rs. 30 crores from export in 2000. In Uttar Pradesh it is mainly cultivated in Bundelkhand region, Gorakhpur, Basti and Behraich districts in an area of 1318 ha with a production of 7001 tonnes and productivity 5.3 t ha^{-1} yr^{-1}. The information pertaining to yield and quality aspects of ginger grown in forest gaps, particularly rehabilitated forest developed on sodic land, is meager and therefore the present experiment was carried out to assess the scope of ginger cultivation in such areas to recover the cost of rehabilitation to some extent by increasing the land use efficiency.

The experiment was carried out at Banthra Research Station of NBRI, Lucknow during 1999 and 2000 in a split plot design with three replications in a forest gap (an open forest) developed on sodic soil. The treatments consisted of three main plots for method of planting *viz.* flat bed, ridges and flat bed followed by earthing up and three sub-plots for different phosphorus levels *viz.* 25, 50 and 75 kg P_2O_5 ha^{-1}. Sodic soil was partially reclaimed through afforestations with *Acacia nilotica, Terminalia arjuna, Albizia procera, Bauhinia variegata, Leucaena leucocephala* etc. in

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random plantings. The soil is silty clay loam with pH 8.5, EC 0.6 dSm^{-1}, organic carbon 0.38%, available N 185 kg ha^{-1}, P_2O_5 28 kg ha^{-1} and K 365 kg ha^{-1}. The average rainfall is 800-900 mm.

The crop was sown on 5th May 1999 and 2000 at a spacing of 50 cm x 25 cm with the rhizome rate of 1500 kg ha^{-1}. The soil was rich in N and K nutrients but deficient in P, therefore phosphorus was applied through single super phosphate as basal dressing as per the treatment schedule. The crop was irrigated weekly in the summer (May and June) through furrow method with tube well water, whereas in rainy season (July to September) no irrigation was given. After that it was irrigated at ten days interval up to first week of December. Two weedings were done during July to September. Growth observations were recorded in November. The crop was harvested in the last week of December during both years of study. The rhizomes were sorted out and quantitative and qualitative yield parameters were studied. Biochemical analysis was done by following the standard methods (AOAC 1984).

The plant height, leaves per clump and tillers per clump were significantly higher in flat bed followed by earthing up over ridge and flat bed planting (Table 1). Similar trend was also observed for leaf length and fresh rhizome yield $plant^{-1}$. It was probably due to flat bed followed by earthing treatment, which increased the surface area for efficient plant nutrition leading to their vigrous growth. Among phosphorus levels, P_2O_5 @ 50 kg ha^{-1} recorded maximum growth viz. plant height, leaves per clump, tillers per clump, leaf length and fresh rhizome yield $plant^{-1}$ over 25 and 75 kg ha^{-1} treatments. Significant differences were found in plant height, tillers $clump^{-1}$ and fresh rhizome yield $plant^{-1}$ for both the treatments under study. The highest dose of phosphorus was rather ineffective to turn out an additional response in growth and yield parameters. The method of planting and phosphorus level had interactive effect on growth parameters because the planting in furrows retains the moisture for a long duration and increases the mobility of P uptake. The effect of interactions was also significant on growth and yield of the crop.

The method of planting and phosphorus levels significantly influenced the yield and quality of ginger (Table 2). Among the methods

Table 1. Effect of method of planting and phosphorus level on growth parameters and rhizome yield of ginger (means of 1999 and 2000)

Treatment	Height of plant (cm)	Leaves $clump^{-1}$	Tillers $clump^{-1}$	Leaf length (cm)	Yield $plant^{-1}$ (g)	
					Fresh	Dry
A. Method of planting						
Flat bed	56.93	14.72	6.68	8.87	95.87	22.05
Ridge	59.56	15.45	7.67	10.33	134.67	30.97
Flat bed with earthing up	70.37	18.98	9.93	12.44	168.43	38.74
SEm ±	0.97	1.11	0.16	0.26	4.10	2.45
CD (5%)	2.70	3.08	0.43	0.71	11.40	6.60
B. Phosphorus level (kg ha^{-1})						
25	55.89	14.13	6.74	8.35	100.74	23.17
50	68.32	17.69	9.55	12.39	165.94	38.17
75	62.65	17.34	8.0	10.89	132.28	30.42
SEm ±	1.22	1.01	0.28	0.19	4.95	2.28
CD (5%)	2.66	2.19	0.60	0.60	10.78	6.25
C. Interaction (AxB)						
SE m ±	1.37	1.23	-	0.26	3.41	1.73
CD(5%)	4.33	3.94	-	0.81	9.80	5.50

Table 2. Effect of method of planting and phosphorus level on rhizome yield and bio-chemical composition of ginger (means of year 1999 and 2000)

Treatment	Yield (t ha^{-1})		Crude protein	Crude fibre	Volatile oil
	Fresh	Dry	(%)	(%)	(%)
A. Method of planting					
Flat bed	5.26	1.21	8.0	4.36	1.13
Ridge	6.66	1.53	8.60	4.89	1.35
Flat bed with earthing up	7.88	1.81	9.0	5.15	1.45
S E m ±	0.12	0.07	0.28	0.14	0.09
CD (5%)	0.33	0.23	0.84	0.41	0.28
B. Phosphorus level (kg ha^{-1})					
25	5.52	1.27	9.0	5.25	1.45
50	7.89	1.81	10.80	6.0	1.85
75	6.39	1.47	9.60	5.25	1.62
SEm ±	0.12	0.05	0.32	0.13	0.11
CD(5%)	0.26	0.17	0.97	0.40	0.35
C. Interaction (AxB)					
SEm ±	0.14	0.10	-	-	-
CD(5%)	0.48	0.32	-	-	-

of planting, flat bed followed by earthing resulted in significantly higher fresh rhizome yield (7.88 t ha^{-1}) followed by ridge planting (6.66 t ha^{-1}) and flat bed planting (5.26 t ha^{-1}). It was due to the fact that in most tuber crops, rhizomes are effectively developed in loose soil and when vegetative growth attains maturity. Earthing provides an increased surface area for better nutrition and rhizome development in tuber crops. Among P levels, P_2O_5 50 kg ha^{-1} recorded the significantly higher fresh rhizome yield (7.89 t ha^{-1}), which was 43% and 23% higher over 25 and 75 kg ha^{-1} treatments, respectively. These results supported the fact that rhizome yield was positively associated with plant height, leaves $plant^{-1}$ and tillers $plant^{-1}$ that determine the development of the rhizomes as reported by Singh & Neopaney (1993), Joseph & Jaychandran (1996) and Gupta *et al.* (2000).

The chemical composition of ginger rhizome revealed that flat bed followed by earthing had a maximum crude protein, crude fiber and volatile oil. Among P levels, P 50 kg ha^{-1} recorded significantly higher value of crude protein, crude fiber and volatile oil. It was probably due to the shade of trees, which restricted the plants to respond to higher dose of P fertilizer. Saikia & Shadeque (1992) and Singh *et al.* (1999) reported that ginger cultivated under North-East condition showed more fiber content and higher volatile oil in comparison to other regions. Rhizome yield and chemical composition of ginger varies with varieties and agro-climatic conditions (Natarajan *et al.* 1972).

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