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Intercropping ginger and turmeric with poplar (*Populus deltoides* 'G-3' Marsh.)

S. C. JASWAL, V. K. MISHRA and K. S. VERMA
Department of Silviculture and Agroforestry, Dr. Y. S. Parmar University of Horticulture and Forestry, P.O. Nauni (Solan) 173 230, India

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Abstract. Performance of two rhizomatous crops i.e. ginger (*Zingiber officinale* Rosc.) and turmeric (*Curcuma longa* L.) was investigated under rainfed conditions in pure stands and as intercrops with 5-year-old poplars planted at three spacings viz., 5 × 5 m, 5 × 4 m and 5 × 3 m. The average illumination below the canopies was 53, 46 and 38% of incident radiation, respectively. Both crops performed better as intercrops than as pure stands. Survival was inversely correlated to light intensity. Plant height, tillers per plant and leaves per plant in ginger and leaf length and leaf breadth besides plant height in turmeric were significantly enhanced when intercropped. The rhizome length, rhizome breadth, yield per plant and yield per ha in ginger exceeded under poplars but showed a drastic reduction under the closest poplar spacing. In turmeric, the trend for the first two characters was the same, whereas yield per plant as well as yield per ha were slightly greater in the open than under 5 × 3 m spacing. Dry matter content varied significantly with spacing. For quality parameters, only oil content in ginger and oleoresin in turmeric showed significant differences. The cultivation of turmeric proved more remunerative than ginger.

Among the poplar spacings, 5 × 4 m for ginger and 5 × 5 m for turmeric were delineated as the best spacings.

Introduction

Ginger (*Zingiber officinale* Rosc.) and turmeric (*Curcuma longa* L.) constitute important rhizomatous cash crops in the mid-hill ecosystems of the western Himalayas. The crops cover an extensive area mainly under rainfed agriculture. There have been numerous attempts to improve their productivity through the introduction of high-yielding cultivars, balanced nutrient supply, improved agronomic practices and protection measures in the region, but as yet we have seen no efforts to explore them as intercrops with trees. Such studies assume a special significance owing to the shade-loving nature of these crops [4, 10] and the rising interest among hill farmers for sustainable agroforestry systems.

Previous investigations on the production of ginger and turmeric below tree canopies viz., teak [4] coconut [8, 13] and arecanut [14, 15], provide excellent data. The present study was intended to extend their evaluation as intercrops with poplar which is an extensively planted agroforestry tree species in the sub-Himalayan region.

Materials and methods

Site description

The study was carried out at the experimental farm of Dr. Y. S. Parmar University of Horticulture and Forestry, Solan, H. P., India during the year 1989. The site lies at 30°50′N latitude and 70°11′E longitude with 1200 m elevation. The climate is transitional between subtropical and temperate with mean annual rainfall 1150 mm, most of which is concentrated during the monsoon period (June—August). The rainfall during the experimental year was atypical; total rainfall was 991 mm with 307 mm during the month of May. The mean monthly maximum and minimum temperature and relative humidity during the period of study varied from 23.1 °—32.1 °C, 4.5 °—20.1 °C and 54.1—85.6%, respectively (Fig. 1). The soil is sandy loam with pH 7.8 and organic-C 0.58%. Available nutrient status of soil was 365 kg N, 10 kg P and 270 kg K ha^{-1} at the start of the study.

Part of the experimental area was under a 5-year-old poplar (*Populus deltoides* 'G-3' Marsh.) plantation raised at three spacings i.e., 5 × 5 m, 5 × 4 m and 5 × 3 m. Growth was independent of spacing with mean height

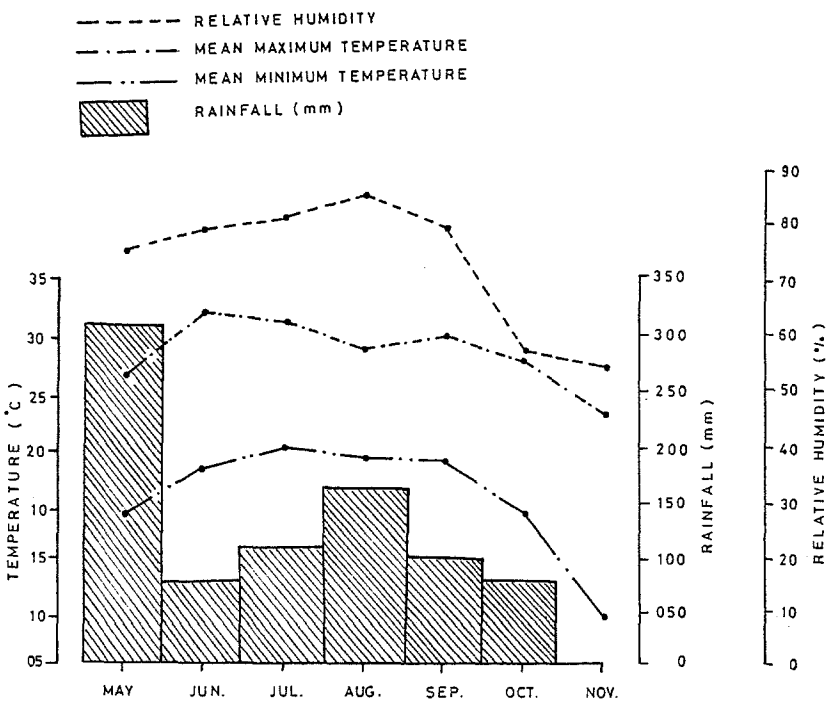

Fig. 1. Meteorological data for the study period.

13.8 m and dbh 13.7 cm. The relative illumination (RI) under 5 × 5 m, 5 × 4 m and 5 × 3 m poplar spacing was computed as 53, 46 and 38%, respectively. The light intensity measurements were made on cloudy days using two Digital DX-100 (1-1 lac lux), Taiwan Make, luxmeters i.e., one under the tree canopy and the other in the open, simultaneously [3].

Methodology

The experiment was laid out in a randomized block design with six replicates. The eight treatments included all possible combinations of the two crops viz., ginger and turmeric with three spacings of poplar and one control for each of the crops. The control studies were conducted in the open area adjoining the plantation. For both crops, local cultivars were sown at 30 × 30 cm spacing on May 27, 1989 using seed rhizomes of 15—20 g after treatment with Dithane M-45 at a rate of 0.2%. The farm yard manure at a rate of 30 tonnes ha^{-1}, P and K at a rate of 50 kg ha^{-1} were added at the time of bed preparation. N was applied at a rate of 100 kg ha^{-1} in ginger and 150 kg ha^{-1} in turmeric in two splits; one at the time of sowing and the other after two months.

Plant height, tillers per plant, leaves per plant, leaf length, leaf breadth and plant survival were recorded during mid-October. The crops were harvested on November 30, 1989 when rhizome length, rhizome breadth, yield per plant as well as yield per ha were recorded. Dry matter was determined after drying the rhizome samples of both crops at 57 °C till constant weights. The quality parameters viz., crude fibre, oleo-resin and oil content, were determined as per procedures outlined by AOAC [2]. Net economic returns in respect of crops were worked out considering material cost, labour cost, interest on working capital and depreciation cost.

Results and discussion

Survival and growth

Survival of ginger as well as turmeric was greater in intercrops, responding positively to increasing shade (Table 1 and 2). Plant height was significantly greater under poplars but manifested a distinct reduction under the closest poplar spacing. Such an increase in plant height due to increase in shade intensity to some level was also observed earlier in ginger [1] and turmeric [5]. Tillers per plant and leaves per plant in ginger and leaf length and leaf breadth in turmeric showed significant differences due to treatments. The growth performance in both crops, in general, was better under poplars but declined appreciably beyond 5 × 4 m spacing. This indicates that intercropping helps promote growth of ginger and turmeric due to the congenial

Table 1. Effect of poplar spacing on survival, growth, yield and quality attributes of ginger.

Parameter	Open (Control)	Poplar spacing (m)			S.E. diff.	C.D. 0.05
		5 × 5	5 × 4	5 × 3		
Survival (%)	86.5	88.7	89.9	93.4	1.81	3.7
Growth						
Plant height (cm)	34.3	50.8	50.6	46.2	3.13	6.4
No. of tiller per plant	1.2	2.1	2.4	1.5	0.15	0.3
No. of leaves per plant	12.4	27.7	27.4	18.1	1.98	4.0
Leaf length (cm)	16.7	17.7	17.7	16.5	1.13	N.S.*
Leaf breadth (cm)	2.0	2.2	2.2	2.1	0.26	N.S.
Yield						
Rhizome length (cm)	4.7	7.0	6.8	6.2	0.53	1.1
Rhizome breadth (cm)	2.0	3.4	3.4	2.9	0.29	0.6
Yield per plant (g)	17.2	30.8	32.9	19.5	2.60	5.3
Yield per ha (q)	16.6	30.3	32.6	20.2	2.35	4.8
Dry matter content (%)	16.4	15.1	15.8	14.7	0.52	1.1
Quality						
Crude fibre (%)	3.9	3.8	3.8	3.7	0.10	N.S.
Oleo-resin (%)	5.4	5.4	5.4	5.3	0.04	N.S.
Oil content (%)	1.0	1.1	1.1	0.9	0.06	0.1

* N.S. = Non-significant.

micro-environment and the shade-loving nature of the crops [12], yet excessive tree cover may affect it adversely [1, 4].

Yield and yield attributes

Rhizome length and rhizome breadth in both crops were greater under poplars but responded negatively to the reduction in spacing (Table 1 and 2).

Yield per plant and yield per ha in ginger were maximum under 5 × 4 m spacing and minimum in pure crops. There was an increase of 83, 96, 22% in yield per ha over control with subsequent increase in shade intensity. Conversely, yield per plant and yield per ha in turmeric were maximum under 5 × 5 m spacing and minimum under 5 × 3 m spacing. The data showed an increase of 145 and 119% and a decline of 5% in yield per ha over control with the increase in shade intensity. A comparison of yield performance in both crops clearly indicates that in partial shade (around 50% RI) intercropping gains were more in turmeric than ginger. Heavy shade (⩽ 38% RI) counteracts the positive effects of intercropping, and results in yields rather comparable to the pure crops [1, 5].

Table 2. Effect of poplar spacing on survival, growth, yield and quality attributes of turmeric.

Parameter	Open (Control)	Poplar spacing (m)			S.E. diff.	C.D. 0.05
		5 × 5	5 × 4	5 × 3		
Survival (%)	85.9	89.1	90.3	92.4	1.81	3.7
Growth						
Plant height (cm)	34.8	60.3	61.1	45.7	3.13	6.4
No. of tiller per plant	1.0	1.1	1.1	1.0	0.15	N.S.*
No. of leaves per plant	5.3	7.1	6.7	4.9	1.98	N.S.
Leaf length (cm)	20.5	28.1	27.1	24.0	1.13	2.3
Leaf breadth (cm)	6.0	8.5	8.4	7.2	0.26	0.5
Yield						
Rhizome length (cm)	4.0	7.5	6.8	4.3	0.53	1.1
Rhizome breadth (cm)	2.0	3.7	3.6	2.3	0.29	0.6
Yield per plant (g)	19.6	46.4	40.8	17.0	2.60	5.3
Yield per ha (q)	18.7	45.9	41.0	17.8	2.35	4.8
Dry matter content (%)	24.0	25.3	25.5	23.4	0.52	1.1
Quality						
Crude fibre (%)	6.9	6.8	6.8	6.7	0.10	N.S.
Oleo-resin (%)	3.2	3.3	3.3	3.1	0.04	0.1
Oil content (%)	2.7	2.8	2.9	2.8	0.06	N.S.

* N.S. = Non-significant.

Dry matter content in ginger as well as turmeric showed significant differences due to different shade regimes. In ginger it was maximum in control and minimum under 5 × 3 m poplar spacing. Whereas in turmeric it was maximum under 5 × 4 m spacing but continued to be minimum in 5 × 3 m poplar spacing.

Quality parameters

Among the quality parameters, the oil content in ginger and oleoresin content in turmeric showed significant differences (Table 1 and 2). The cultivars, environment and state of maturity at harvest have been reported as the possible factors for causing quality variation in the crops [6, 7, 9, 11]. Since the cultivar used in both crops was the same under all the treatments, the varied micro-climate under different treatments and the resultant state of maturity at harvest could probably be the basic reasons for causing slight variations in values.

Net returns from ginger and turmeric as pure and intercrop

The net returns (Rupees per ha) from ginger were computed to be negative when it was raised as pure or intercrop with poplar (Fig. 2). The quantum of loss, however, was maximum when it was raised as pure crop and minimum under 5 × 4 m spacing. In respect of turmeric, 5 × 3 m spacing and control yielded negative returns, whereas 5 × 5 m, closely followed by 5 × 4 m spacing, proved quite remunerative. The negative returns in both crops may be attributed to lower yields mainly because of the long spell of severe drought experienced during the experimental period.

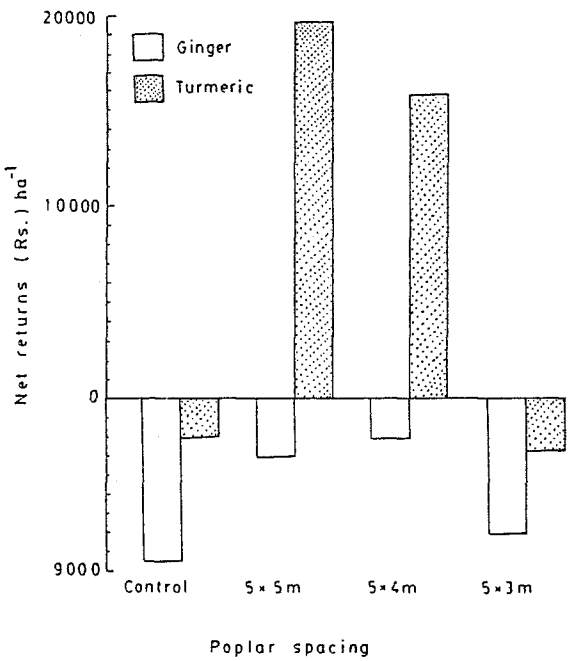

Fig. 2. Net return from ginger and turmeric under pure cultivation and as intercrop with poplar.

Conclusions

Both ginger and turmeric performed better as intercrops. Though the crops are shade-loving in nature, high tree density may hamper their growth, yield and quality. In general, crops produce maximum at around 50% RI. The performance of both, pure crops and intercrops, was low primarily due to the scanty and erratic moisture supply during the investigation period. There is a need to conduct more studies in respect of ginger and turmeric as intercrops

with agroforestry tree species under varying environments on a long-term trial basis. The research should concentrate not only on the shading effect of trees but also on allelopathy as well as competition at the tree-crop root interphase.

References

1. Aclain F and Cuisumbing EC (1976) Fertilizer, mulch and light attenuation on the yield and quality of Ginger. Philippine Agriculturist 60(5/6): 183—191
2. AOAC (1980) Official Methods of Analysis, 13th ed. Association of Official Analytical Chemists, Washington, DC
3. Blackman GE and Wilson GL (1951) Physiological and ecological studies in the analysis of plant environment VI. The constancy for different species of a logarithmic relationship between net assimilation rate and light intensity and its ecological significance. Ann Bot 15: 67
4. Lahiri AK (1972) Intercropping trials with Turmeric in North Bengal. Ind For 98: 109—115
5. Lalitha Bai EK (1981) Shade response of common rainfed intercrops of coconut. M.Sc. (Agri.) Thesis, Kerala Agri. Univ. Thrissur, Kerala, India
6. Marwaha S (1984) Propagation studies in Ginger. M.Sc. Thesis, HPKVV, Palampur, India, 44 pp
7. Nair PCS (1980) Agronomy of Ginger and Turmeric. In: The proceedings of the National Seminar on Ginger and Turmeric, pp 63—68. CPCRI, Calicut, India
8. Nair PKR (1979) Intensive Multiple Cropping with Coconuts in India: Principles, Programmes and Prospects. Verlag Paul, Parey, Berlin, 147 pp
9. Natarajan CP, Padmabai R, Krishnamurthy MN, Raghavan BR, Sankaracharya NB, Kuppuswamy S, Govindrajan VS and Lewis YS (1972) Chemical composition of Ginger varieties and dehydration studies on Ginger. J Food Sci Technol, India 9: 120—124
10. Neopaney B (1988) Effect of different levels of (NPK) essential elements and spacing on growth and yield of Ginger (*Zingiber officinale* Rosc.). M.Sc. Thesis, Dr. Y. S. Parmar University of Horticulture and Forestry, Solan, H. P., India, 49 pp
11. Purseglove JW, Brown EG, Green GL and Robbins SRJ (1981) Spices, Vol 2. Longman Inc, New York, 813 pp
12. Safania S, Chandra S and Etherington DM (1982) A review of recent research on intercropping under Coconuts. Fiji Agric J 44: 31—36
13. Satheesan KV and Ramadasan A (1980) Growth and productivity of Turmeric grown as a pure and as an intercrop in Coconut garden. In: The proceedings of the National Seminar on Ginger and Turmeric, pp 69—75. CPCRI, Calicut, India
14. Singh RK, Bhalerao MM and Reddy MJM (1986) Costs and returns of intercrops in Arecanut. Ind Cococa, Arecanut and Spices J 9(4): 99
15. Thangaraj T, Muthuswamy S, Muthukrishanan CR and Khader JBMMA (1983) Performance of Ginger (*Zingiber officinale* Rosc.) varieties of Coimbatore. South Ind Hort 31: 45—46