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Peach based agroforestry systems in degraded foothills of north-western Himalayan region

P.L. Saroj*, D.S. Tomar and Y.K. Arora

Central Soil and Water Conservation Research and Training Institute, Dehradun (UP)-248 195, India
**Present address: National Research Centre for Arid Horticulture, Bikaner-334006 (Rajasthan),*
Email: nrcah@hub1.nic.in

Abstract

The investigation revealed that peach orchard can be raised successfully even on degraded land by adopting site specific agrotechnique. The porous profile with only 60 cm top soil depth (T_3) favoured better vegetative vigour of peach plants as compared to those sites having soil only throughout the profile (T_4 and T_5). The drip system of irrigation had good response on plant survival but overall plant vigour was not influenced much in juvenile peach plants as compared to rain fed control under humid subtropical climate. Production of urd (*Phaseolus vulgaris*, variety T-9) in *kharif* and toria (*Brassica campestris*, variety Pant-303) in *rabi* season was a compatible combination with peach plantation but growing of annual crops particularly *rabi* season crop was uneconomical on highly gravely sites (80% gravels distributed throughout profiles-T_2). The yield of groundstorey crops were affected by rainfall distribution pattern during crop growing period coupled with canopy cover of the overstorey component but there was no any adverse effect of groundstorey crops on peach plantation. By this rotation, a net income of Rs. 9068/- ha^{-1} can be obtained every year under rainfed conditions. The yield and net income were increased with increasing depth of top soil in the profiles.

Keywords: Peach, agroforestry systems, degraded foothills, Himalayan region, intercrops

Introduction

Peach is one of the important stone fruits grown largely to the midhill zone of Himalayas extending from Jammu and Kashmir to Khasi hills at an altitude of 1500 to 2000 m asl. A sizeable area is also covered by low chilling cultivars in submountainous region and western part of the country, *i.e.* Punjab, Haryana, Delhi and western Uttar Pradesh (Srivastava, 1974) and to a limited scale in the hills of south India and in north-eastern region (Ghosh, 1976). The peach is very precocious and prolific bearing fruit tree and fruit comes in the market during summer and early monsoon when other fruits are in scarcity in the market, hence peach orcharding considered as remunerative farming enterprise. The susceptibility of plants to water logging and perishable nature of fruits are main constraints in peach orcharding.

Peach is an important multipurpose tree as it gives; fruit, fuel wood by pruning and to some extent fodder by removal of excessive and overcrowding branches. The tree is deciduous in nature, therefore, it has special significance to enrich the soil by their leaf litters (Saroj, 1994). A large number of intercrops are also grown with peaches based on agroclimatic suitability and need of the farmers (Saroj and Arora, 1994) but the work done so far on peach based agri-horti systems are confined to good lands only. It has been also reported that integration of some of the groundstorey crops like lemon grass (Ghosh and Chand, 1984), okra and onion (Kaul and Mitra, 1976) had adverse effect on peach plants, which suggested judicious selection of groundstorey crops in peach orchard. Moreover, bringing additional area under peach based agroforestry systems is least possible due to reduction in land:man ratio. However, a large area known as *torrent bed* is bouldery river bed land in foothills of Himalayan region and lying either vacant or under utilised. Therefore, it was proposed to utilize these degraded land by peach based agroforestry systems.

Materials and methods

The investigation was carried out at Central Soil and Water Conservation Research and Training Institute, Research Farm, Dehradun (UP), during 1995 to 1998 under degraded foothills of north-western Himalayan region. Geographically the area is located at a latitude of 30° 20' 4' N and longitude 72° 52' 12' E and about 680 m asl. The average annual rainfall during the experimental period was more than 1600 mm. The experimental site was gravely river bed land formed by debris deposition eroded from adjoining hills. Therefore, the site was highly heterogeneous in nature. This heterogeneity of site was considered as treatment to assess the growth and production of tree-crop combinations. Pits of 1 m^3 size were dug out at a spacing of 7x7 m and 4 types of variability was observed after opening of the profiles *i.e.* i) Pit profiles having good soil up to 80 cm depth and then gravel starts, ii) pit profiles having soil and gravel mixed throughout the profile, iii) pit profiles having up to 60 cm top soil then gravel starts and iv) pit profiles having good soil throughout the profile. Thereafter, the soil and stone ratio was worked out by weighing the excavated materials and based on

the profile characteristics five treatments were made including one farmers practice *i.e.* rainfed control while in all other four treatments the drip system had been installed for irrigation of peach plants. Based on soil:stone ratio, the treatments were T_1 (75:25), T_2 (20:80), T_3 (50:50), T_4 (100:0) and T_5 (100:0)-rainfed control. The fertility status of the experimental site was very poor; having more than 48% coarse sand alone, 10.2% silt and 8.51% clay content, owing to high infiltration rate. The organic carbon content was 0.52% and N was 0.06%. The soil reaction was acidic in nature (pH 6.7).

The pits were filled by the excavated material, after sorting out of bigger stones (> 5 cm dia), mixed with 1 ft^3 FYM. The peach cultivar 'Pratap' (a early bearing and low chilling type) was planted in December, 1995 followed by light irrigation. The recommended dose of fertilizers were given every year. Irrigation was given uniformly as and when desired through drip system except control (T_5). In the *Kharif*, 1996, no intercrop was grown in order to provide enough strength to the plants. From winter, 1996 a short duration crop toria (*Brassica campestris* var. Pant 303) was introduced while in *Kharif*, 1997 leguminous crop urd (*Phaseolus vulgaris* var. T 9) was grown. The same cropping system was repeated up to 1998. The groundstorey crops were grown under rainfed basis. The intercultural operations, pest and diseases management were done uniformly in all the treatments. Mulching in tree basin was also done uniformly by dry grasses every year. Though, the plants came in flowering in second year but up to 3 years age fruits were not allowed.

The experiment was laid out in randomised block design having three replications. The data on plant growth and crop yield were recorded every year and analysed statistically. The economics of cropping at prebearing phase of orchard was also computed based on prevailing market rates and produce was auctioned on spot.

Results and discussion

Plant survival: Perusal of the data presented in Table 1 indicated that the maximum plant survival was recorded in T_3 (98%) followed by T_1 (95.25%), T_4 (92.5%), T_2 (90%) and minimum in rainfed control *i.e.* T_5 (86.85%). In fact, in this investigation there were two main variables which affected the survival percentage of peach plants under degraded land *i.e.* i) profile variability and ii) status of irrigation. It is obvious with the former variable that even under similar management the site variability had great influence on plant survival but it was not necessary that better profile had given higher percentage of plant survival (T_4) and *vice-versa* (T_2). The plant survival was maximum in T_3 followed by T_1 indicated that porous profile had better effect on plant survival but very high porosity had adverse effect on plant survival, as the water holding capacity of the profile having 80% gravels (T_2) was very poor. Whereas, with latter variable *i.e.* drip system had good impact on plant survival and all the treatment had given better response over rainfed control (T_5). The maximum increase in plant survival over control (T_5) due to irrigating orchard through drip system was in T_3 (11.38%) followed by T_1 (8.82%), T_4 (8.10%) and minimum in T_2 (3.50%).

Table 1. Survival of peach plants under different treatments

Treatment	Soil: Stone (by weight)	Distribution of stones in profile	Per cent plant survival	Per cent increase over control
T_1	75:25	Lying below 80 cm soil profile	95.25	8.82
T_2	20:80	Mixed throughout the profile	90.00	3.50
T_3	50:50	Lying below 40 cm soil profile	98.00	11.38
T_4	100.00	Free from stones	94.50	8.10
T_5*	100:00	Free from stones	86.85	—

* Rainfed control as farmer's practice

Plant vigour: The peach plants were trained by modified central leader system of training and side branches were allowed above 1 meter from the ground level. Pruning was done every year during dormant season. The growth parameters like plant height, crown spread and collar diameter of scion were recorded every year at grand growth period (middle of April). The maximum plant vigour was recorded in T_3 followed by T_5, T_1, T_4 and minimum in T_2 (Table 2). Initially, the differences among different treatments were non-significant but with increasing age of tree, the differences among them were significant. It was obvious that the plant vigour under T_5 (rainfed control) was very appreciable and no significant difference was observed between T_5 and T_3 with respect to plant height. This indicated that under good soil profile, even under rainfed condition peach plants can grow well. It was also apparent that though the plant height was lowest in T_2 but collar diameter was maximum in this treatment. This suggested that porous soil profile favoured the better plant stature *i.e.* thick stem and balanced canopy. Regarding rate of growth increment, no definite trend was observed but in general, rate of growth increment was higher at initial years than later age of plant life. There was no any adverse response observed on the growth of peach plants by growing intercrops. Contrary to this, Kanwar *et al.* (1993) found that intercrops always had detrimental effect on tree growth in all peach orchards while surveying on status of intercropping of orchards in Punjab.

Yield of groundstorey crops: Urd-toria rotation was adopted under rainfed basis in all the treatments as groundstorey component in peach orchard. The dry matter and grain yield was recorded every year after harvesting the crops. There was no much difference in dry matter and grain yield of urd and toria among T_1, T_3, T_4, and T_5, but significant difference was observed between T_2 and rest of the treatments (Table 3). On an average > 16.72 q ha^{-1} dry matter and > 4.74 q ha^{-1} grain yield of urd was harvested every year in all the treatments except T_2. Similarly > 12.57 q ha^{-1} dry matter and >3.79 q ha^{-1} grain yield

of toria was harvested every year except T_2. It was also observed that there was no adverse effect of overstorey component (peach) on the crop stand of toria. The reason being, during winter peach plants shed their leaves which facilitate better radiation to groundstorey component (toria), thereby no yield reduction of toria crop was observed in the vicinity of tree up to 3 years age and combination is considered as compatible. However, in case of urd the crop stand was better with increasing lateral distances from tree trunk. This was due to shading effect of overstorey component. Growing urd has additional advantage in soil improvement as the crop is leguminous in nature. The findings are in conformity with Arora and Mohan (1986) where they suggested growing of leguminous crop (cowpea) up to 4 years and shade loving crop (turmeric) beyond 6 years in peach orchard were economically viable agri-horti model in Doon valley.

Data presented in Table 3 clearly indicated that though there was no much difference with respect to yield of groundstorey crops among various treatments except T_2 but there was marked variation under different years of cropping. The yield response was better in 1997 as compared to 1996 and 1998 for both the crops. The effect was more prominent during *rabi* season as compared to *kharif* season. The differences of yearly variation in dry matter and grain yield of groundstorey crops were mainly due to difference in rainfall distribution pattern during the crop growing season coupled with canopy cover of overstorey component. The yield of groundstorey crops was also slightly poor in those plots where the plant vigour was maximum (T_3). The reduction in yield of groundstorey crops with increasing canopy cover of overstorey component has already been reported by Saroj and Arora (1994) under similar agroclimatic conditions.

Table 2. Growth parameters of peach under different treatments

Treatments	Plant height (m)				Crown spread (m)				Collar diameter (cm)			
	1995	1996	1997	1998	1995	1996	1997	1998	1995	1996	1997	1998
T_1	0.91	1.62	2.60	4.15	—*	0.87	1.65	3.72	0.89	2.69	5.58	9.60
	—	(43.83)	(37.69)	(37.35)	—	—	(44.24)	(55.65)	—	(66.91)	(51.79)	(41.88)
T_2	0.89	1.40	2.32	3.60	—	0.84	1.71	3.41	0.87	2.39	5.28	10.96
	—	(36.43)	(39.66)	(35.56)	—	—	(50.88)	(49.85)	—	(63.60)	(54.73)	(51.82)
T_3	0.89	1.57	2.62	4.45	—	0.74	2.10	4.38	0.89	2.70	5.99	11.60
	—	(43.31)	(40.08)	(41.59)	—	—	(64.76)	(52.05)	—	(61.04)	(54.92)	(48.36)
T_4	0.91	1.60	2.77	3.88	—	0.97	2.01	3.39	0.88	2.66	5.52	9.86
	—	(43.13)	(42.24)	(28.61)	—	—	(51.74)	(40.71)	—	(66.92)	(51.81)	(44.00)
T_5	0.88	1.49	2.51	4.32	—	0.81	1.64	3.77	0.90	2.88	5.11	9.15
	—	(40.94)	(40.64)	(41.90)	—	—	(50.61)	(56.50)	—	(68.75)	(43.64)	(44.15)
CD (p=0.05)	NS	NS	NS	0.48	—	NS	0.33	0.60	NS	0.43	NS	1.45

Values in parenthesis are percentage annual increase over previous year, * Just single stem at initial stage.

Table 3. Dry matter and grain yield of intercrops grown with peach

Treatment	Urd						Toria							
	Dry matter (q ha^{-1})			Grain yield (q ha^{-1})			Dry matter (q ha^{-1})				Grain yield (q ha^{-1})			
	1997	1998	Mean	1997	1998	Mean	1996	1997	1998	Mean	1996	1997	1998	Mean
T_1	17.81	16.52	17.17	5.08	4.65	4.87	12.71	13.30	12.20	12.74	4.03	4.35	3.27	3.88
T_2	7.71	8.15	7.93	2.15	2.26	2.21	4.30	4.50	3.12	3.97	1:47	1.52	1.02	1.34
T_3	17.49	15.95	16.72	5.00	4.69	4.75	11.69	13.13	12.15	12.57	3.89	4.23	3.26	3.79
T_4	17.85	16.18	17.02	5.09	4.38	4.74	12.69	13.55	12.46	12.90	4.15	4.43	3.28	3.95
T_5	17.99	16.29	17.14	5.13	4.72	4.93	12.08	13.63	12.42	12.71	4.12	4.52	3.82	4.15
CD (5%)	0.43	0.80	—	0.13	0.06	—	0.03	0.20	0.09	—	0.06	0.08	0.05	—

Table 4. Economics (Rs ha^{-1}) of intercrops grown with peach orchard

Treatment	Income by Urd (Pooled 1997 and 1998)			Income by Toria (Pooled 1996 to 1998)			Gross output (Rs/ha) (a+b)	Gross input (Rs ha^{-1})	Net return (Rs ha^{-1})	B:C
	Stover	Grain	Total (a)	Stover	Grain	Total (b)				
T_1	1811.50	7297.00	9108.50	254.67	3495.00	3749.67	12858.17	3400.00	9458.17	3.78
T_2	793.00	3307.50	4100.00	79.67	1203.00	1282.67	5303.00	3400.00	1903.00	1.56
T_3	1672.00	7267.50	8939.50	246.67	3281.33	3528.00	12467.50	3400.00	9067.50	3.67
T_4	1740.00	7102.50	8842.50	258.00	3563.00	3821.00	12663.50	3400.00	9263.50	3.72
T_5	1714.00	7387.50	9101.50	254.00	3738.00	3992.00	13093.50	3400.00	9693.50	3.85

Economics: To assess the economic viability of this agri-horti system, the economics was worked out based on prevailing rates in the locality. The maximum net return of Rs. 9694 ha^{-1} was recorded in T_5 followed by T_1 (Rs. 9458 ha^{-1}), T_4 (Rs. 9264 ha^{-1}), T_3 (Rs. 9068 ha^{-1}) and minimum in T_2 (Rs. 1903 ha^{-1}). The B:C ratio also followed similar trend *i.e.* 3.85, 3.78, 3.72 and 3.67 in T_5, T_1, T_4, and T_3, respectively by giving lowest B:C ratio in T_2 (1.56) suggested that cropping in highly degraded soil without amelioration particularly during *rabi* season was economically not viable. The present investigation revealed that peach orchard can be raised successfully even on degraded land and a net income of Rs. > 9068 ha^{-1} $yr.^{-1}$ can be obtained by adopting urd-toria rotation in peach orchard.

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