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INFLUENCE OF ORCHARD MANAGEMENT STRATEGIES ON GROWTH, YIELD, QUALITY AND LEAF MINERAL CONCENTRATIONS IN CHERRY Cv. 'BIGARREAU NOIR GROSS (MISRI)'

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ABSTRACT

The effect of various orchard floor management treatments of young cherry trees (*Prunus avium* L) cv. Bigarreau Noir Gross (Misri) on growth, yield, quality and leaf mineral element concentrations were investigated during the year 2008 and 2009 at Ambri Research Station, Pahnoo, Shopian SKUAST-K Shalimar. The treatments included growing of *kharif*- and *rabi*-sown intercrops viz., maize, pea, strawberry, cabbage, red clover, french bean and oats along with a control (clean cultivation). The results revealed that young cherry trees intercropped with leguminous crops (pea, red clover or french bean) performed better with respect to growth, yield, quality and leaf mineral element concentration than control or intercropping with heavy feeder crops (strawberry, cabbage, oats or maize). Higher produce and heavier fruit was obtained from the cherry trees intercropped with pea followed by red clover and french bean. The firmness, colour and ascorbic acid content were high in fruits from cherry trees intercropped with red clover or French bean.

Key words: Apple, intercrops, mineral elements, orchard management, legumes, heavy feeder crops

INTRODUCTION

Cherry (*Prunus avium* L.) is one of the most important fruit grown in temperate regions. It belongs to family Rosaceae and is believed to originate from the region between Black sea and Caspian sea (Westwood, 1993). The global cherry production is estimated to be 20,64,421 tonnes obtained from an area of 3,68,524 ha (FAO, 2010). In India the cherry crop is cultivated on an area of 3,600 ha with annual production of around 15,300 tonnes. Jammu & Kashmir and some parts of Himachal Pradesh and Uttaranchal are the main cherry cultivating areas in India. Jammu & Kashmir state alone contributes 96 and 75% of the area and annual produce, respectively (Anonymous, 2011). Under Kashmir conditions cherry fruit attains market maturity within 60-70 days after full bloom and is the first temperate fruit to reach the market thereby fetches premium price. Most of the area under cherry crop in J&K state is rainfed. Having a slow growth in initial or formative years, the interspaces between cherry plantations not only remain unproductive but also become vulnerable to weeds so add to production costs. Intercropping is, therefore, one of the most important factors of orchard soil management system. Orchardists usually cultivate several crops in between tree spacing to avoid infestation of perennial weeds. These perennial weeds go deeper into soil for moisture and transpire a lot of water. Due to crop-weed competition fruit trees suffer from water stress so cause a set-back to fruit yield and quality. Tasseva (2005) studied the effect of orchard floor management on 'Van' sweet cherry and observed 16% increase in plant girth, 30% increase in plant volume and substantial increase in fruit weight when pea was used as intercrop. Highest leaf N and K content was recorded in plum cv.

'Santa Rosa' on green manuring with cow pea followed by intercropping with french bean (Shylla *et al*., 1999). Effective orchard soil management is key to profitable and sustainable fruit production as it controls weeds, conserves soil moisture, prevents soil erosion, maintains soil organic matter and structure, improves water infiltration and nutrient retention, thereby enhances the fruit quality (Derr, 2001).

Chifflot *et al*. (2006) compared wild cherry (*Prunus avium* L.) and hybrid walnut (*Juglans nigra* L.; *J. regia* L.) grown in association with non-irrigated cereal crops in agroforestry treatment against weeded control or fallow, and observed that intercropping increased plant girth and growth in both the species right from the 2nd year. Leaf biomass assessment using allometric models showed an earlier and greater leaf biomass increase in hybrid walnut than in wild cherry tree. After six years, the relative growth increase of agroforestry trees in comparison to control trees varied in the parameter studied i.e. diameter at breast height from +26 to +65% and leaf biomass from +54 to +142%. The proper intercropping system seems to be a possible solution to improve food supply, stabilize income and improve the tree nutrition for small marginal farmers. The present investigation was aimed to determine the sound and feasible orchard management strategy under reainfed conditions of Kashmir to achieve better growth and yield in cherry cv. "Biggarreau Noir Gross (Misri)".

MATERIALS AND METHODS

The experiment was conducted on 9 year old bearing cherry trees grafted on 'Colt' rootstock at Ambri Research Station, SKUAST-Kashmir, Pahnoo, Shopian (J&K) during the years 2008 and 2009. The plants were spaced 4 x 4 m apart. Intercultural operation was done on 4 plants $plot^{-1}$ with plot size of 16 m^2. The experiment comprized of 8 treatments each replicated thrice in a randomized block design. During these two years the vegetative growth in terms of plant height, spread, volume and annual extension growth were measured as per the standard procedures (Westwood, 1993). Maize (*Zea mays*), cabbage (*Brassica oleracea* var. *captata*) and french bean (*Phaseolus vulgaris*) were sown as *kharif* (summer) crop while as pea strawberry (*Fragaria ananossa*), cabbage, red clover (*Trifolium repense*) and oats (*Avena sativa*) as *rabi* (winter) crop. All the cultural practices were adopted as per the package of practices of SKUAST-K. Cultivation of *rabi* crop was followed by *kharif* in first year and again repeated in next year with same sequence. The data on yield parameters were recorded as per cent fruit set and fruit retention in each experimental plot calculated at fruitlet stage. The initial and full blooms were recorded as the dates of opening of first flower (10%) and full bloom (80%), respectively. The dates were converted into days after reference date which was set arbitrarily as March 1st. Fruit maturity was worked out from the date of full bloom to the date when the fruits were actually harvested. Individual fruits were scored for skin colour using 1-5 scale (Webster and Goldwin, 1981). The fruit weight, firmness and vitamin C content were recorded as per Westwood (1993). Leaf total nitrogen was determined by micro-Kjeldhal's method (AOAC, 2007), total phosphorus by vando-molybedate phosphoric yellow colour method (Jackson, 1967) and total potassium by neutral normal ammonium acetate method using flame photometer (Merwin and Peech, 1950). The other nutrients were estimated as per Snedecor and Cochran (1989). Calcium and magnesium content in leaf were determined by atomic absorption spectrophotometer. The data was subjected to statistical analysis in S-plus software.

RESULTS AND DISCUSSION

Intercrops significantly influenced growth of cherry plants in terms of annual extension and height, spread and volume. Maximum plant height (62, 55 and 53 cm), spread (61, 58 and 54 cm), plant volume (0.98, 0.77, 0.63 cm^3) and annual extension growth (55.80, 54.76 and 53.48 cm) was recorded in treatments intercropped with pea followed by red clover and french bean (Table 1). Clean cultivation (vegetation-free) promoted more tree growth than complete vegetative cover under the trees. It appears that leguminous crops not only provided the N nutrient timely but also P and K which significantly

improved plant growth and facilitated greater nutrient uptake. However, heavy feeder crops like maize and oats showed more competition for moisture and nutrients and transpired more. Under moisture stress conditions premature terminal bud sets in cherry trees. Once the terminal bud is set, no further shoot elongation occurs thereby resulting in further decrease in growth. The findings are in congruence with Sanchez *et al.* (1995) who noticed that when cover crops like strawberry, clover, alfalfa, vetch, and control were used as treatments about 46% clover nitrogen was mineralized as a result of which tree growth parameters and fruit yield got enhanced. However, Chifflot *et al.* (2006) found that intercropping in cherry trees increased growth parameters like height, girth and spread in comparison to fallow or clean cultivation perhaps due to the better nutrient acquisition in the soils of low fertility.

Table 1: Effect of intercrops on growth parameters of cherry cv. Misri

Cherry intercropped with	Plant height (cm)			Plant spread (cm)			Plant volume (m^3)			Annual extension growth (cm)		
	2008	2009	Mean	2008	2009	Mean	2008	2009	Mean	2008	2009	Mean
Maize	25	27	26	38	40	39	0.10	0.12	0.11	44.05	46.06	44.85
Pea	60	64	62	61	62	61	0.92	1.06	0.98	53.70	56.09	55.80
Strawberry	39	42	40	45	47	46	0.28	0.35	0.30	48.47	50.18	49.22
Cabbage	37	39	42	42	44	43	0.24	0.28	0.26	47.10	49.51	48.73
Red clover	56	58	55	57	59	58	0.75	0.83	0.77	52.44	55.09	54.76
French bean	52	54	53	53	55	54	0.60	0.67	0.63	51.82	54.79	53.48
Oats	31	32	33	40	42	41	0.16	0.18	0.17	46.04	48.94	47.96
Control*	48	50	49	50	52	51	0.48	0.54	0.51	50.75	52.08	50.82
$CD_{0.05}$	0.15	0.32	0.12	0.11	0.23	0.10	0.01	0.02	0.01	0.73	0.42	0.42

*Clean cultivation

Orchard management strategy remarkably influenced fruit set, fruit maturity and fruit yield (Table 2 and 3). The cherry trees intercropped with pea followed by red clover and french bean recorded highest fruit set, fruit yield and earlier fruit maturity than those intercropped with heavy feeder crops like strawberry, cabbage, oats and maize. However, cherry trees in control (clean cultivation) recorded higher fruit set and yield than the cherry trees intercropped with oats and maize. This might be attributed to the fact that clean cultivation improves soil physical condition which, in turn, enhanced nutrient uptake. Further, the nutrient supply for bud opening gets restricted in case of heavy feeder crops thereby enhances the number of days required for fruit maturity. The results are in conformity with Sanchez *et al*. (2003) who found same results by vegetative mulch cover in cherry.

Physical characteristics of cherry fruit like weight, colour and firmness showed remarkable increase when intercropped with pea, red clover and french bean but improvement was less in case of

Table 2: Effect of intercrops on initial bloom, full bloom, fruit maturity (reference date 1st March) and percent fruit set in cherry cv. "Misri"

Treatments	Initial bloom (days)			Full bloom (days)			Fruit set (%)			Fruit maturity (DAFB upto date of harvest)		
	2008	2009	Mean	2008	2009	Mean	2008	2009	Mean	2008	2009	Mean
Maize	37.8	38.2	38.0	42.2	43.2	42.7	10.0	11.0	10.49	74.7	76.0	75.4
Pea	32.0	33.7	32.9	36.9	37.8	37.3	12.1	13.3	12.48	69.2	70.9	70.0
Strawberry	35.8	36.8	36.3	40.6	42.0	41.3	10.3	11.3	11.82	72.9	73.9	73.4
Cabbage	36.7	37.9	37.3	41.5	42.1	41.8	10.1	11.1	10.60	72.7	73.7	73.2
Red clover	33.6	34.8	34.2	37.8	38.8	38.3	11.3	12.6	11.97	69.8	70.7	70.2
French bean	34.9	35.7	35.3	38.7	39.9	39.3	11.0	12.3	11.66	70.9	71.6	71.2
Oats	37.6	38.0	37.8	42.0	43.1	42.5	10.1	11.0	10.51	73.6	74.8	74.2
Control*	35.6	36.1	35.8	39.1	40.2	39.6	10.5	11.8	11.18	71.7	73.0	72.4
$CD_{0.05}$	0.22	0.32	0.14	0.12	0.88	0.05	0.32	0.24	0.26	0.42	0.60	0.26

*Clean cultivation; DAFB = Days after full bloom

Table 3: Effect of intercrops on weight, yield, firmness and colour of cherry fruit cv. "Misri"

Treatments	Fruit weight (g)			Fruit firmness (kg cm^{-2})			Fruit colour*			Fruit yield (kg $tree^{-1}$)		
	2008	2009	Mean	2008	2009	Mean	2008	2009	Mean	2008	2009	Mean
Maize	3.43	3.45	3.44	0.21	0.22	0.21	3.48	3.65	3.57	14.00	15.60	14.90
Pea	4.05	4.08	4.06	0.26	0.26	0.26	4.00	4.27	4.15	16.84	17.75	17.30
Strawberry	3.61	3.63	3.62	0.25	0.25	0.25	3.75	3.90	3.84	15.18	16.20	15.70
Cabbage	3.52	3.54	3.53	0.23	0.24	0.26	3.59	3.77	3.68	14.75	15.35	15.09
Red clover	3.98	4.01	3.99	0.28	0.28	0.28	4.67	4.83	4.76	16.50	17.53	17.04
French bean	3.85	3.88	3.86	0.27	0.27	0.27	4.33	4.50	4.42	16.15	17.33	16.75
Oats	3.48	3.50	3.49	0.22	0.23	0.22	3.50	3.70	3.64	14.10	15.66	14.89
Control*	3.74	3.76	3.75	0.25	0.26	0.26	3.89	3.99	3.95	15.55	16.40	15.98
$CD_{0.05}$	0.30	0.34	0.31	0.01	0.01	0.01	0.36	0.45	0.27	0.04	0.32	0.21

*Fruit colour: Dark red = 5; Red = 4; light red = 3; Straw coloured = 2; Green = 1; **Clean cultivation

heavy feeder crops like oats and maize (Table 3). Fruit weight was highest (4.06 g) in cherry trees intercropped with pea followed by red clover (3.99 g) and french bean (3.86 g). Fruit firmness (0.28 kg $cm^{-2)}$, colour (4.76) and ascorbic acid content (3.74 mg 100^{-1} g fruit) were highest in trees intercropped with red clover followed by french beans and pea. The legumes particularly clovers seem to have increased water infiltration capacity of soils which, in turn, enhanced the nutrients uptake especially those of K and Ca which needs prerequisite amount of soil moisture for uptake. The control and heavy feeder crops decreased rates of water infiltration perhaps due to surface sealing, compaction and unfavourable particle size distribution. The observations are in line with Sirrine *et al*. (2008) who observed that ground cover management system significantly influenced the yield, leaf nutrient status, nutrient uptake and reserve nitrogen in ground and permanent tissues from previous growth cycles. Besides this, in late summer and autumn nitrogen and other nutrients move from annual tissues to perennial tissues. Remobilization of these reserves from woody tissues is the main driver of early season fruit, leaf nutrition and leaf growth and has been correlated with leafy canopy management. Clovers reportedly increase water infiltration capacity of soil and also extract moisture from deeper layers of soil which might have facilitated the Ca uptake and firmness of fruits due to Ca binding to cell wall pectin polymerss. These findings are in agreement with Dris *et al.* (2002).

Maximum leaf N and Mg contents were observed in cherry trees intercropped with pea, red clover and french bean and lowest in heavy feeder crops (maize, oats, cabbage and strawberry). Control (clean cultivation) plants had higher N and Mg than heavy feeder crops (Table 4). The leguminous crops have a symbiotic relationship with *Rhizobium* species which is capable of fixing atmospheric nitrogen, so increase available soil N while clovers increase infiltration capacity of soil and

Table 4: Effect of intercrops on leaf nutrient status in cherry cv. "Misri"

Treatments	Nitrogen (%)			Phosphorus (%)			Potassium (%)			Calcium (%)			Magnesium (%)		
	2008	2009	Mean	2008	2009	Mean	2008	2009	Mean	2008	2009	Mean	2008	2009	Mean
Maize	2.40	2.50	2.46	0.162	0.170	0.167	1.79	1.81	1.80	2.23	2.25	2.24	0.20	0.22	0.21
Pea	2.66	2.75	2.72	0.185	0.193	0.190	1.95	1.98	1.97	2.38	2.40	2.39	0.40	0.43	0.41
Strawberry	2.51	2.63	2.58	0.178	0.186	0.183	1.87	1.91	1.90	2.31	2.33	2.32	0.28	0.30	0.29
Cabbage	2.48	2.56	2.53	0.176	0.184	0.182	1.85	1.88	1.87	2.28	2.30	2.31	0.26	0.28	0.27
Red clover	2.62	2.70	2.67	0.208	0.216	0.213	2.06	2.09	2.08	2.48	2.50	2.49	0.36	0.39	0.38
French bean	2.58	2.64	2.62	0.191	0.199	0.196	2.00	2.03	2.02	2.43	2.45	2.44	0.34	0.37	0.36
Oats	2.43	2.52	2.48	0.170	0.178	0.175	1.81	1.84	1.83	2.26	2.28	2.27	0.22	0.24	0.23
Control*	2.54	2.64	2.59	0.180	0.187	0.184	1.90	1.93	1.92	2.33	2.35	2.34	0.31	0.33	0.32
$CD_{0.05}$	0.03	0.04	0.02	0.011	0.027	0.013	0.05	0.04	0.02	0.04	0.02	0.01	0.03	0.02	0.01

*Clean cultivation

enhance nutrient uptake. These results are in conformity with Hoagland *et al*. (2008) who noticed mobilization of Ca and Mg by legume covers and enhancement in microbial activity in cherry rhizosphere. Highest leaf phosphorus, potassium and calcium contents were found in cherry trees intercropped with red clover and lowest in trees intercropped with heavy feeder crops. This might be due to the fact that oats and maize remove large amount of moisture and nutrients from soil so their availability to main crop gets drastically reduced, while red clover or other legumes improve soil physical conditions thereby facilitates more nutrient uptake. These findings are in agreement with Shylla and Chauhan (2004) who observed highest nutrients in plum trees intercropped with french bean.

Conclusions: The study revealed that intercropping cherry trees with legume crops like pea, red clover and french bean is beneficial for sustainable development of horticulture as it improves plant growth and yield. Legume crops such as clovers should be used as companion crops to improve physical conditions and water holding capacity of soil.

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