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Ground-cover management studies in kinnow orchard

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ABSTRACT

The six ground-cover species viz. aloe vera, brahmi, lemongrass, mentha, stevia and turmeric, were grown in the kinnow orchard. The cultivation of mentha, intercropped with kinnow, exhibited better performance in terms of fruit length (5.81cm), fruit breadth (6.77 cm), fruit weight (156.50 g) and fruit yield (61.04 Kg), followed by brahmi as compared to other treatments. The quality attributes like juice content, total soluble solids (TSS), titratable acidity (TA), and TSS/TA of fruits grown under different intercropping systems were statistically at par with control during the first year of study. However, the highest juice content (46.32 %), TSS (11.28 %), TSS/TA (14.25) and minimum TA (0.79 %) were recorded in kinnow intercropped with mentha. The highest leaf N content was recorded in the cover crops of Kinnow + mentha (1.97 %), P and K content in Kinnow + brahmi (0.20 and 1.35 %, respectively), while these were found to be the lowest in control. Overall, Kinnow + mentha and Kinnow + brahmi proved to be effective intercropping systems in the Kinnow growing areas.

Key words: Intercropping, Fruit quality, Medicinal and aromatic plants, Nutrient status

INTRODUCTION

Citrus is one of the major sub-tropical fruit crops grown in more than 90 countries. Kinnow mandarin has taken over 93 per cent of the total space for the cultivation of citrus fruits in India. The scope for Kinnow cultivation is increasing because of its adaptability to different agro-climatic conditions, early bearing, excellent yield, and fruit quality, which ensures better returns to the farmers (Dalal *et al.*, 3).

The inter-row space area in most commercial orchards is often left fallow, which is generally either regularly tilled at intervals or sprayed heavily with herbicides to control weeds. These practices encourage soil degradation, which leads to a reduction in quality as well as fruit yield (Novara *et al.*, 12). However, ground cover (GC) management practices can significantly enhance soil characteristics like organic carbon (OC) and nutritional status as compared to clean tillage (Garcia *et al.*, 5). The ground-cover systems have been reported to boost the fruit yield and weight by 2.0-47.6 per cent and 1.6-9.2 per cent, respectively, over standard tillage practices (Thakur *et al.*, 18). In the loess hilly-gully region of China, the interculture of cover crops in apple orchards statistically enhanced the fruit yield (Zheng *et al.*, 20). In most developing countries, approximately 80 per cent of the population prefers classical medicines produced from different medicinal and aromatic plants (Pan *et al.*, 13). The entire "Ayurveda," "Sidha," and "Unani" systems of Indian medicine, as well as some aspects of homoeopathy, rely on products derived from plants to treat illnesses (Prajapati *et al.*, 14). Tree plantations, fruit orchards and home gardens are the appropriate options for commercially cultivating medicinal and aromatic plants. It is possible to intercrop many tropical medicinal and aromatic plants (MAPs) with fruit trees and plantation crops because of their adaptability under partial shadow and moderate temperature conditions combined with moist soil (Vyas and Nein, 19). The fruit weight, size, and pulp weight of aonla significantly improved intercropping with turmeric (Das *et al.*, 4). Similarly, coconut-based intercropping depicted the enhanced yield per tree due to mixed cropping of medicinal and aromatic plants (George *et al.*, 6). Besides, intercropping of MAPs improved coconut's production and leaf nutrient status due to additional nutrient management (Basavaraju and Nanjappa, 2). The cultivation of herbal plants viz., A. galangal, Aloe vera, O. sanctum, C. flexuosus and P. patchouli under coconut-based intercropping system improved the 18 per cent annual nut yield compared with control. Therefore, this study mainly focused on the effect of MAPs on the productivity and quality of fruits grown in the orchards under Kinnow-based intercropping systems in Punjab conditions.

MATERIALS AND METHODS

The study was performed at the Experimental Orchard, Department of Agriculture, Khalsa College, Amritsar, Punjab during 2019-21. Agro-climatically, The average minimum and maximum temperature is 0.6-1 °C and 41.8-48 °C in winter and summer, respectively. The experimental site is classified as

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sandy loam-textured soil characterized by 7.76 pH, 0.42 dS m−1 electrical conductivity (EC), and 0.44 per cent organic carbon (OC) N 202.37 kg ha-1 N, 21.25 kg ha-1 P and 291.56 kg ha-1 K.

Kinnow plantation of 11 years old with spacing 6m × 6 m had sufficient space for intercropping. The trial was conducted in a randomized block design (RBD), having seven treatments and replicated thrice. The treatment combinations were as under: T1: Kinnow+aloe vera (Aloe barbadensis M.), T2: Kinnow+brahmi (Bacopa monnieri L.), T3: Kinnow+lemongrass (Cymbopogan flexuosus L.), T4: Kinnow+mentha (Mentha arevensis L.), T5: Kinnow+stevia (Stevia rabaudiana B.), T6: Kinnow+turmeric (Curcuma longa L.) and T7: Kinnow sole block (control). A field plot size of 5 m x 2 m was selected for intercropping with MAPs. The recommended practice packages were used for both the main crop and intercrops. Well-decomposed farmyard manure (FYM) was applied @ 10 t ha-1 to all the plots uniformly except for control and incorporated into the soil before planting every year.

Ten fruits were chosen randomly at harvest from two selected trees per replication of each treatment. Vernier callipers and electronic balance were used to measure the fruit's weight and size. The quality parameters, viz., juice per cent, TSS, TA and TSS/TA were analyzed using standard methods (AOAC, 1; Malik and Singh, 11). Leaf samples from each tree of the experiment were collected to examine the macro-nutrient status of Kinnow tree. The leaf nitrogen (N) was analyzed by using Kjeldahl method (Kjeldahl, 10), while leaf phosphorus (P) and potassium (K) were estimated as per the method of Jackson (9). The data were analyzed as one way analysis of variance (ANOVA), and differences were considered statistically significant at p≤0.05 using the statistical software Statistix 8.1.

RESULTS AND DISCUSSION

The data relating to the influence of ground cover crops on yield and Kinnow's yield-contributing traits are presented in Table 1. The ground cover crops failed to influence the fruit length statistically. However, the highest fruit breadth (6.77cm) was recorded in T4 (Kinnow + Mentha), which is statistically at par with T1, T2, T3, and T6 treatments. Intercropping with Mentha in Kinnow orchard (T4) tended to produce the heaviest fruits (156.50g) and highest fruit yield (61.04 Kg/tree) over other combinations. The lowest fruit weight (140.70g) and yield (49.06 Kg/tree) were recorded in the sole Kinnow plantation with no significant difference with T1 and T5 for fruit weight and T5 for yield. Intercropping systems produced better fruit yield than sole crops due to the establishment of microclimate, which enhanced the number of fruit and yield (Sahoo, 15). Similar results were found in peach orchards (Sharma *et al.*, 16).

Table 1. Effect of ground-cover management practices on yield and yield parameters of Kinnow (Pooled means for two years).

Treatments	Fruit length (cm)	Fruit breadth (cm)	Fruit weight (g)	Fruit Yield/ tree (kg)
T_1: Kinnow + Aloe-vera	5.57	6.48^{ab}	143.02^{de}	54.30^{c}
T_2: Kinnow + Brahmi	5.76^{a}	6.70^{ab}	152.09^{b}	57.68^{b}
T_3: Kinnow + Lemongrass	5.60^{a}	6.56^{ab}	146.00^{cd}	54.80^{bc}
T_4: Kinnow + Mentha	5.81^{a}	6.77^{a}	156.50^{a}	61.04^{a}
T_5: Kinnow + Stevia	5.54^{a}	6.46^{b}	143.56^{de}	50.67^{d}
T6: Kinnow + Turmeric	5.67^{a}	6.62^{ab}	148.83^{c}	56.21^{bc}
T_7: Kinnow (Sole)	5.49^{a}	6.40^{b}	140.70^{e}	49.06^{d}
LSD (≤0.05)	NS	0.30	3.14	3.20

Various ground cover crops were found statistically at par for the contents of fruit juice and TSS; however, the content of titratable acids and TSS: acid (TA) ratio were significantly influenced by cover crops (Table 2). The cultivation of Brahmi (T2) and Mentha (T4) in the Kinnow orchard resulted in the production of the fruits with the lowest acid content (0.79% in each) over others. T4 (Mentha) treatment also contributed the highest TSS/TA in Kinnow fruit (14.25), followed by T2 with no significant difference. Similar quality attribute results were reported in mango (Swain, 17) and Kinnow mandarin (Gill *et al.*, 8).

The nitrogen (N) and phosphorus (P) contents in Kinnow leaf were significantly affected due to ground

Table 2. Effect of ground-cover management practices quality attributes of Kinnow (Pooled means for two years).

Treatments	Juice content (%)	TSS (°B)	Titrat-able acidity (%)	TSS/TA
T_1: Kinnow + Aloe-vera	45.22^{a}	11.03^{a}	0.81^{abc}	13.56^{cd}
T_2: Kinnow + Brahmi	46.70^{a}	11.22^{a}	0.79^{c}	14.18^{ab}
T_3: Kinnow + Lemongrass	45.68^{a}	11.05^{a}	0.81^{abc}	13.62^{bcd}
T_4: Kinnow + Mentha	46.32^{a}	11.28^{a}	0.79^{c}	14.25^{a}
T_5: Kinnow + Stevia	44.96^{a}	10.98^{a}	0.83^{ab}	13.24^{d}
T6: Kinnow + Turmeric	45.69^{a}	11.15^{a}	0.80^{bc}	13.90^{d}
T_7: Kinnow (Sole)	44.58^{a}	10.93^{a}	0.84^{a}	13.04^{d}
LSD (≤0.05)	NS	NS	0.03	0.60

Table 3. Effect of ground-cover management practices on leaf nutrient status of Kinnow (Pooled means for two years).

Treatments	N (%)	P (%)	K (%)
T_1: Kinnow + Aloe-vera	1.92^{ab}	0.17^{ab}	1.30^{a}
T_2: Kinnow + Brahmi	1.95^{ab}	0.20^{a}	1.35^{a}
T_3: Kinnow + Lemongrass	1.91^{ab}	0.17^{ab}	1.31^{a}
T_4: Kinnow + Mentha	1.97^{a}	0.19^{a}	1.33^{a}
T_5: Kinnow + Stevia	1.88^{ab}	0.17^{ab}	1.26^{a}
T6: Kinnow + Turmeric	1.96^{a}	0.18^{ab}	1.35^{a}
T_7: Kinnow (Sole)	1.85^{b}	0.15^{b}	1.24^{a}
LSD (≤0.05)	0.11	0.04	NS

cover crops. However, all the treatments were proved statistically at par with each other for potassium (K) content (Table 3). The highest leaf N content (1.97%) was registered with Mentha cover crop (T4), proving it statistically superior to control. The level of P was relatively highest, with Brahmi (0.20%) following a similar trend to that of N.

The lowest nutrient content of Kinnow leaves was registered in the sole orchard. The increased NPK status in leaves of Kinnow tree grown with MAPs intercropping system might be due to the bio-mass incorporation from intercrops and availability of moisture which improved the physico-chemical properties that facilitate the easy nutrient uptake from a nutrient pool of the soil (Ghosh and Pal, 7).

The current findings revealed that cultivation of MAPs as intercrop improves the yield and quality of Kinnow orchard under sub-tropical environments. Among all the treatments, intercropping of mentha, brahmi, and turmeric significantly enhanced the yield, quality, and leaf nutrient status of the Kinnow orchard compared to the sole plantation. Therefore, adopting intercropping of MAPs to Kinnow growers is suggested for better fruit quality and yield.

AUTHORS' CONTRIBUTION

Conducting field experiment, data collection and manuscript drafting(MS); Conceiving the idea and manuscript editing (MS);data analysis and manuscript editing (VS)

DECLARATION

There is no conflict of interest in this manuscript.

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