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Research Article

Augmenting the production and quality of Kiwifruit var. Allison through manual thinning and pruning

Thejangulie Angami, H. Kalita, Anup Chandra, Jitendra Kumar, Badapmain Makdoh, K. Suraj Singh, Letngam Touthang

Abstract

On well pollinated seven years old kiwifruit vines var. Allison, different hand thinning severities of fruitlets were executed under the Sub-tropical mid hill conditions. Among the different hand thinning treatments, thinning to retain two fruits and four fruits per fruiting shoot with regular winter pruning exhibited significantly higher fruit size of length (7.21 ± 0.02 cm, 7.13 ± 0.11 cm), breadth (5.35 ± 0.06 cm, 5.24 ± 0.09 cm) and average fruit weight (83.69 ± 1.44 g, 82.37 ± 0.53 cm). The fruit number per vine and total yield declined with an increase in the severity of thinning, whereas the control treatment (no thinning and pruning) exhibited the highest fruit number per vine (457.65 ± 1.09) and total yield (31.94 ± 1.47 kg). Though the maximum production was observed in control yet the yield of grade 'A' fruit was the least (8.88 ± 0.91 kg) resulting in the lowest net profit (Rs. 1240 per vine). Manual thinning by retaining six fruits per fruiting shoot yielded optimum thinning and the highest production of 'A' grade fruits (23.48 ± 2.62 kg) with the highest net profit (Rs. 2290 per vine) over other treatments. The experiment also vividly revealed that TSS, sugars, ascorbic acid content as well as pigments *viz.* likes total chlorophyll and carotenoids of fruits increased as the intensity of thinning was augmented.

Keywords *Actinidia deliciosa*, hand thinning, kiwifruit, pruning, yield

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Introduction

Kiwifruit (*Actinidia deliciosa* Chev.), is regarded as one remarkable fruit of the previous century which has replaced the old English name of 'Chinese gooseberry'. The horticultural wonder of New Zealand and 'China's miracle fruit' [1] is a deciduous dioecious vine belonging to the family Actinidiaceae bears a rusty brown fruit with a hairy surface and a light green fruit pulp with a beautiful pattern of light green colored rays illuminating from the center and embedded in between are numerous small black seeds. Being a scrambling perennial climber, it requires strong structural support [1].

In recent years, kiwifruit has gained popularity in a short period among consumers across the world and India in particular owing to its deliciously refreshing taste, nutritive values, health benefits, and economic viability. According to the Economic Survey of Arunachal Pradesh report, 2016-17, the state of Arunachal Pradesh has about 3379

hectares of land producing about 6047 tonnes of fresh kiwi fruits contributing more than 50 percent to the total kiwifruit production [2]. Despite being the largest kiwifruit yielding state, the overall productivity of kiwifruit in the state of Arunachal Pradesh is very low (1.2 MT/ha) in comparison to other states such as Nagaland (12 MT/ha) and Mizoram (3.4 MT/ha) [3]. Not following the scientific agro-techniques in general and thinning and pruning, in particular, are the main reason behind the low productivity.

In the kiwifruit crop, the burden of bearing a heavy load of fruits is the main factor that influences the production of various grades of fruit size [4] *viz* 'A' grade (> 100 g), 'B' grade (70-100 g) and 'C' grade (< 70 g). Fruit size and quality are also crucial characteristics determining the marketability and price of kiwifruit. At present, due to the poor marketing system in the district, the products are sold in the local market. However, with due course of time, with developing marketing system and value chain and further establishment of processing and wine unit, cold storage, and packaging infrastructure there is ample scope for this crop to be the mainstream fruit for export purposes.

Most kiwifruit varieties are prolific bearers which often resulted in the production of small mediocre fruits. Thus, thinning through crop regulation, timely and regular pruning is needed to acquire better size quality fruit as there is a positive parallel relationship between the number of fruits and yield [5]. Keeping this in view, an investigation was conducted to study the influence of manual hand thinning and pruning on fruit yield and quality of kiwifruit var. Allison is under the subtropical mid hill conditions of Arunachal Pradesh.

Methodology

The experiment was executed in the year 2016-19 on seven-year-old kiwifruit vines cv. Allison at Sago circle, Basar under Leparada district, Arunachal Pradesh located in the sub-tropical hill zone at the latitude of 27°59.537' N and longitude of 94°41.269' E with an altitude of 1200 m above sea level having sandy loam soil with pH of 4.8 (acidic). The mean annual precipitation of the site is approximately 2100 mm, out of which, nearly 79% falls between May and September [6]. The mean annual temperature of the region is 16.2 °C, with a maximum monthly mean value of 22.2 °C (August) and a minimum monthly mean value of 07.9 °C (January). The aim was to study the influence of manual hand thinning and pruning on fruit yield, quality of kiwifruit cv. Allison. The kiwifruit plants were planted maintaining a distance of 4 m x 6 m, trained to T-bar system, and were kept under standard and uniform cultural practices. The fruits were thinned out as desired as soon as the fruits were set and proper canopy management through regular winter pruning was carried out at the dormant stage in which the fruiting lateral is cut back to two vegetative buds beyond the last fruit. In the subsequent year, these vegetative buds produce the fruiting shoot, which is pruned again accordingly to maintain the balance between vegetative and reproductive growth for fruit production. The field experiment consisted of five treatments with five replications following Randomized Block Design viz. T1: retaining two fruits per fruiting shoots + pruning; T2: retaining four fruits per fruiting shoots + pruning; T3: retaining six fruits per fruiting shoots + pruning; T4: Pruning with no thinning; T5: control (no thinning with no pruning).

For measuring the physical parameters of the fruits, 10 randomly selected fruits harvested from each tree were considered as one replication. Average fruit weight was measured with an electronic balance having 0.1 g accuracy. For the estimation of total soluble solids (TSS), a drop of juice was used with a calibrated digital refractometer (0-32°Brix). Acidity was ascertained by titrating against 0.1N sodium hydroxide using an indicator i.e. phenolphthalein (with the endpoint of light pink) and depicted as a percentage in terms of citric acid [7]. Total and reducing sugar were determined by Anthrone and Nelson Somogyi method as outlined by Sadasivam and Manickam [8] where the final samples were read and interpreted against the blank solution (without color) in a UV visible spectrophotometer at 630 and 620 nm respectively. Ascorbic acid (Vitamin C) content was

analyzed by the process outlined by Ranganna [9]. Chlorophyll and carotenoid content were ascertained by the procedure outlined by Arnon [10] and Lichtenthaler [11] respectively. The three years of recorded data were pooled further subjected and placed to statistical analysis using Statistical Analysis System 9.3 computer software (SAS Institute Inc., 13). DMRT (Duncan's Multiple Range Test) methods were used at a P = 0.05 level to ascertain the significant differences among the means.

Results and Discussion

Fruit size and average fruit weight elevated with an increase in the thinning intensity (Table 1).

Table 1. Effect of thinning and pruning on physical attributes and yield of kiwifruit var. Allison

Treatments	Fruit length (cm)	Fruit breadth (cm)	Av. Fruit weight (g)	No. of fruits per vine	Total yield (kg per vine)	Marketable yield (kg per vine)	
						Grade A (> 70 g)	Grade B and C (30 – 70 g)
T1	7.21a ± 0.02	5.35a ± 0.06	83.69a ± 1.44	282.10a ± 1.23	23.93a ± 1.55	20.83a ± 1.13	3.10a ± 0.34
T2	7.13a ± 0.11	5.24a ± 0.09	82.37a ± 0.53	315.10b ± 2.14	24.98a ± 0.74	20.73b ± 1.44	4.25b ± 0.44
T3	7.00b ± 0.11	4.96b ± 0.17	80.31b ± 1.73	358.35c ± 3.60	28.32b ± 1.54	23.48b ± 2.62	4.84c ± 0.54
T4	6.42c ± 0.07	4.73c ± 0.08	66.65c ± 1.03	436.95d ± 0.73	30.81c ± 1.49	10.48c ± 0.44	20.33c ± 0.99
T5	6.21d ± 0.05	4.57d ± 0.19	65.49c ± 0.93	457.65e ± 1.09	31.94c ± 1.47	8.88c ± 0.91	23.06d ± 0.81
SEm ±	0.038	0.049	0.60	0.97	0.59	0.66	0.24
CD (0.05)	0.114	0.147	1.80	2.92	1.79	2.01	0.71

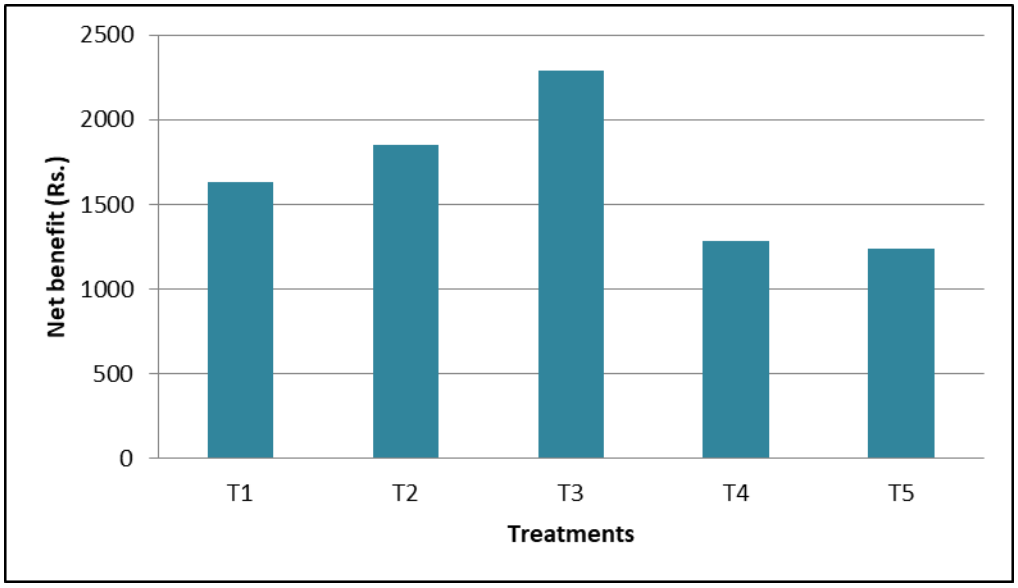

Figure 1. Effect of hand thinning on net benefit per vine

Thinning to retain two fruits and four fruits per fruiting shoot with regular winter pruning exhibited significantly higher fruit size length (7.21 ± 0.02 cm, 7.13 ± 0.11 cm), breadth (5.35 ± 0.06 cm, 5.24 ± 0.09 cm) and average fruit weight (83.69 ± 1.44 g, 82.37 ± 0.53 cm). The larger fruit size and weight is probably because of lesser fruit number and a higher ratio of leaf to fruit on thinned vines that aid in translocation and availability of more photosynthates, assimilates, and food material and lesser nutritional competition among the developing fruits [12] simultaneously manual thinning

out of smaller fruitlets may result in larger fruit size [13]. However, fruit number per vine and total yield alleviated with an increase in the severity of thinning, whereas the control treatment (no thinning and pruning) recorded the maximum number of fruits per vine (457.65 ± 1.09) and total yield (31.94 ± 1.47 kg). Simultaneously, the yield of grade A fruits elevated, and grade B and C fruits quelled down as the manual thinning intensity increased (Table 1). Although the highest total yield (31.94 ± 1.47 kg) was recorded in control whereas the yield of grade A fruit was least (8.88 ± 0.91 kg) resulting in the lowest net profit (Rs. 1240 per vine). Retaining six fruit per fruiting shoot through thinning divulged in optimum thinning and the highest production of grade A fruits (23.48 ± 2.62 kg) with the highest net profit (Rs. 2290 per vine) over other treatments (Figure 1). Yehia et al., [14] pointed out that the fruit number retained on a tree and tree yield was a straight reflection of thinning severity, whereas tree revenue was positively affected by fruit size. The greater production and proportion of grade A fruits following manual thinning are because of the increase in the fruit weight and size. This is in agreement with Thakur and Chandel's results [13]. It was found that there was an increment in sugar level viz. TSS, reducing sugars, total sugars, and ascorbic acid (Vitamin C) content of fruits and decreases acidity as the intensity of manual thinning was elevated (Table 2).

Table 2. Effect of thinning of fruitlets and canopy management on fruit quality attributes of kiwifruit var. Allison

Treatments	TSS (°Brix)	Titratable Acidity (%)	Reducing sugar (%)	Total sugar (%)	Ascorbic acid (mg/100 g)
T1	13.92a ± 0.67	0.62a ± 0.03	7.52a ± 0.08	10.82a ± 0.68	82.28a ± 0.63
T2	13.16a ± 0.39	0.69b ± 0.03	6.78b ± 0.09	10.03b ± 0.52	82.87a ± 0.23
T3	13.22a ± 0.85	0.68c ± 0.02	6.77b ± 0.10	9.69bc ± 0.31	79.52b ± 0.54
T4	11.61b ± 0.94	0.84c ± 0.08	6.23c ± 0.11	8.91cd ± 0.78	69.97c ± 1.35
T5	11.22b ± 0.76	0.91d ± 0.05	6.10d ± 0.06	8.51d ± 0.31	67.50d ± 0.20
SEm ±	0.32	0.02	0.04	0.26	0.29
CD (0.05)	0.94	0.06	0.13	0.79	0.88

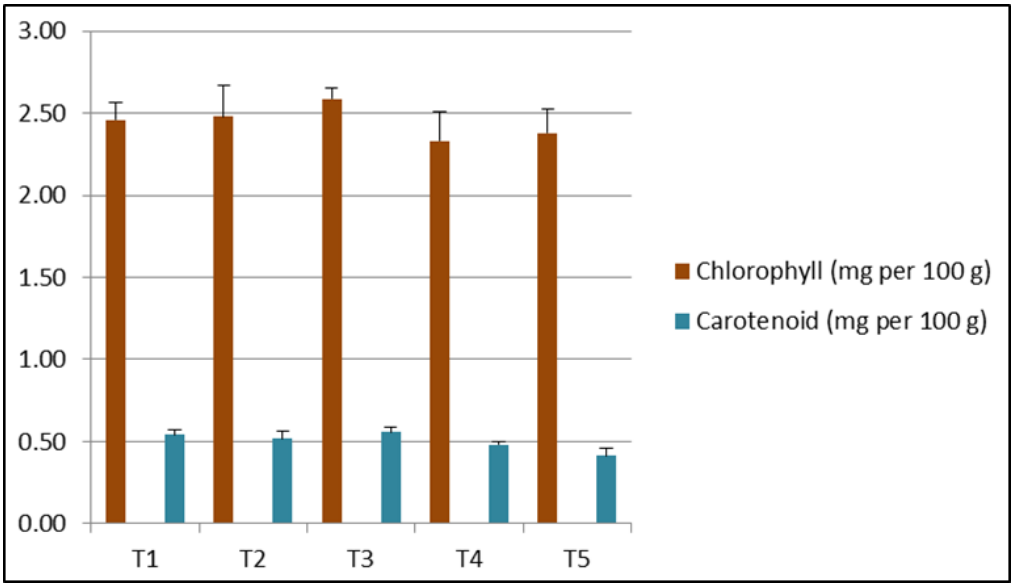

Figure 2. Total chlorophyll and carotenoid content

Improvement in soluble solids, sugar level, and ascorbic acid content must be due to diminishing crop load following manual thinning, ultimately elevating the leaf to fruit ratio, giving

rise to more synthesis, transport, and amassing of sugars in the remaining fruits, thereby enhancing the nutritional content [12]. Improvements in sugar and ascorbic acid content through thinning were also substantiated by Kong et al., and Solomakhin and Blanke [15-16]. An increase in chlorophyll and carotenoid pigments in the thinned fruits (Figure. 2) is probably due to the thinning of fruits which further resulted in diminishing the competition among the fruits for food materials, vitamins, minerals, and metabolites which aids in the quicker accumulation of colored pigments [17].

Conclusion

This three years of research work vividly indicated that manual hand thinning and pruning were found effective in improving the fruit size, yield, and quality of kiwifruit without the use of chemical inputs in the remote areas of the state where the access to the availability of chemicals and growth regulators are almost impossible. This simplified technology can be considered a farmers' friendly practice for sustaining long-term fruit production even without the exogenous use of chemicals and this would open a better road map for marketing not only in the local markets but also in markets outside the district. Further in the future, studies on managing crop load by different severities of pruning are vital as pruning influences shoot vigor and return bloom in the subsequent years.

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