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Pruning Severity and timeInfluences the Shoot Growth, Fruiting and Quality Attributes of Ber (*Zizyphus mauritiana* L), cv. Seb under Arid Kachchh Conditions

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ABSTRACT: A pruning experiment with seven pruning severity with five pruning times was conducted to standardize the pruning severity and time in ber cv. Seb. Data were recorded on days to bud sprouting (day), days to fruiting (day), fruit set (%), fruit weight (g), fruit length (mm), fruit diameter (mm), and total soluble solids (TSS) during the experiment. Set of data indicates, intensive pruning up to 4 buds resulted in early bud sprouting (21.20 days), fruiting (129.93 days), fruit weight (6.58 g), and fruit size (24.07 × 23.39 mm). As the pruning severity decreased, the time to bud sprouting and fruiting was delayed and fruit size was also reduced but fruit set (%) was increased. The fruit TSS (°B) increased with pruning severity up-to-the 6 buds (30.37°B), and it decreased significantly with a decrease to the lowest content in trees pruned at 12 buds (27.57 °B) and control plants (25.58 °B). The maximum fruit set (17.38%) and higher fruit weight (6.33 g) and size (23.72 × 23.75 mm) were recorded when the trees were pruned on 20th May. Hence, moderate pruning up to the 6 buds on 20th May, could enhance the fruit yield and fruit quality of Ber under the arid Kachchh conditions.

Keywords: Arid Kachchh, pruning time, pruning severity, Seb, *Zizyphus mauritiana.*

INTRODUCTION

Zizyphus mauritiana Lamk (Rhamnaceae), is a local, drought-tolerant, and hardy fruit crop which is also known as Ber, Indian jujube, or poor man's fruit. Consumption of ber fruit provides a rich supply of vitamin C, A, protein, and mineral nutrients especially phosphorus and iron. However, nowadays improved and grafted varieties fetch the good market price and this crop is no longer fits in the poor man fruits definition. The area under this crop increased in the last two decades and was cultivated commercially by farmers of arid and semiarid regions of India, mainly because of its hardy nature, good adaptivity, high yield, and good return at low production and maintenance cost. Among all cultural operations contributing to high yield and quality fruits, regular and judicious pruning is the most vital operation. Pruning is also essential to maintain the plants in a productive state, improve fruit quality, and repair the injury in the plant. Ber is pleonanthic, which means it blooms multiple times on the same plant. On the current season's new shoots, fruits are produced in the axils of leaves. As a result, either through pruning or reiteration, more sylleptic (instant) branching must be induced on proleptic (delayed) growth (Reddy, 1983). Because, ber trees produce the flowers and fruits in the axil of leaves on young shoots of current season's growth and fruiting generally remains restricted on secondary and tertiary shoots of the plants (Reddy, 1983). Therefore, regular annual pruning should aim to remove old and unwanted wood and promote the appearance of a higher number of secondary and tertiaries shoot (Meghwal *et al.,* 2017), otherwise, old wood continues to grow and accumulate wood biomass every year, and canopy becomes large and tall with the barren centre. In ber cultivar like Jobner, Rahuri, Hissar, and Bangalore, pruning of main axis at 4-6 secondaries, gave higher fruit yield (Reddy, 1988). If plants are left unpruned, the tree becomes less productive with low-quality fruits due to shading and competition among any but small-sized fruits. Hence pruning in ber crop is the most crucial to maintain fruit productivity, tree vigour, fruit quality, and size (Singh *et al.,* 2004). Additionally, Pruning helps plants with better air and sunlight penetration in the canopy which positively affects fruit growth and yield. The best advantages of pruning can be achieved when done at the right time with the right intensity (Meghwal *et al.*, 2017). However, pruning severity is determined by several factors like local agro-climatic conditions (Pandey *et al.* 1998), cultivar (Nathakumar & Shanmugavelu 1990), and spacing (Bisla *et al.* 1991). In general, the best time for pruning is when the tree is incomprehensive rest or dormancy which promotes the emergence of the vigorous shoot. (Kaith *et al.* 2011) reported higher vegetative growth in the apple tree in response to severe pruning. Additionally, severe pruning in the old tree is favourspur maintenance and growth, while in younger trees reduced spurs. While severe pruning of old can form the base of blueberry is essential to get optimum fruit yield (Pescie *et al.,* 2011). As, copious flowering, as well as fruiting in a particular season, is a result of high utilization of limited metabolites like carbohydrates, which ultimately affects fruit set and development (Panwar & Rana, 2019). Kurian, (1985) stated that vigorous shoots of pruned trees produce about 98% of fruits and only 2% of fruits are produced on other shoots. The appropriate pruning time and intensity are region-specific and can vary among the different ber varieties. Optimization of pruning time and intensity for particular variety in the particular climatic region is the major challenge. Therefore, present study was undertaken to examine the effect of various pruning intensities and time on plant growth, fruit yield, and high quality under the arid Kachchh region of Gujarat.

MATERIAL AND METHODS

The field experiment was carried out to investigate the response of ber cv. Seb to the different pruning severity and time in the year 2017. The experimental site was the Arid horticulture block of ICAR – Central Arid Zone Research Institute, Regional Research Station, Kukma, Bhuj (latitude 23°21′19″ - 23°21′33″ N, longitude 69°79′72″ - 69°78′78″E). The climate of the experimental site is hot and arid with a maximum temperature of 48° C during summer and a minimum of 2° C during winter. The average rainfall of the Kachchh region is 326 mm and most of the rainy days occur from July to September with high evapotranspiration that ranges from 1500-2000 mm per year. In general soil of the experimental site was sandy loam to silty loam with minimum and maximum soil pH (7.0 - 9.0) and EC (0.10 – 2.71 dSm^{-1}). The fifteen-year-old ber plants were selected for the pruning severity experiment and uniform recommended cultivation practices except pruning were carried out during the experiment. The one tree per treatment per replication was selected using a randomized block design with three replications. The secondary branches of selected trees were pruned at weekly intervals *i.e.* on 13th May, 20th May, 27th May, 03rd June, and 10th June with seven pruning intensities *i.e.* leaving 2 buds, 4 buds, 6 buds, 8 buds, 10 buds, 12 buds and leaving all buds (no pruning) in each branch. The exposed parts of the pruned shoot were covered with Bordeaux mixture paste to avoid any microbial infection. Just after the pruning plants were monitored regularly for recording days to bud sprouting (day) and days to fruiting (day), while fruit set (%) was calculated after the flowering started. Twenty representative mature fruits were picked randomly from each treatment and these fruits were then analyzed for different yield traits like fruit weight (g), fruit length (mm), fruit diameter (mm), and total soluble solids (TSS) in the laboratory. Fruit TSS (° B) was measured with the help of a digital refractometer (Atago N 1, Brix 0~32%, Japan). Fruit length and diameter were estimated through the electronic digital vernier caliper. For determination of percent fruit set, ten cymes were selected on the pruned secondary branches, and before to anthesis, flowers were counted in each cyme. The percent fruit set was recorded 15-20 days after the petal fall as follows.

$$\text{Fruit set (\%)} = \frac{\text{Total no. of fl}}{\text{Total no. of fruits}} \times 100$$

The statistical analysis of data was carried out in a randomized block design with a factorial arrangement. Experimental data were analyzed using the statistical software package for agricultural research workers (Sheoran *et al.* 1998).

RESULTS AND DISCUSSION

The significant effect of various pruning intervals and pruning intensities on the day to bud sprout of ber cv. Seb was noted. Among different pruning intensities, intensive pruning (at 2 buds), resulted in earlier bud sprouting (19.47 days) and was closely followed by pruning leaving 4 buds (21.20 days). As pruning intensity decreases, bud sprouting was delayed. Pruning of branch at 12 buds took higher time for bud sprouting (26.0 days), while, control plant (no pruning) sprouted very late (after 29.87 days) which was almost delayed by 10 days, compared to intensive pruning (leaving 2 buds) treatments. The earliest bud sprout was noted when plants were pruned on May 27 (20 days), followed by May 13 (22.57 days). However, the late bud sprouting (26.71 days after pruning) was recorded in the plants pruned in June (*i.e.* 10thJune). The interaction of pruning time and pruning severities shows a significant variation in sprouting time. The earliest bud sprouting was noted when the plant pruned leaving 2 buds on May 27 (Fig. 1).

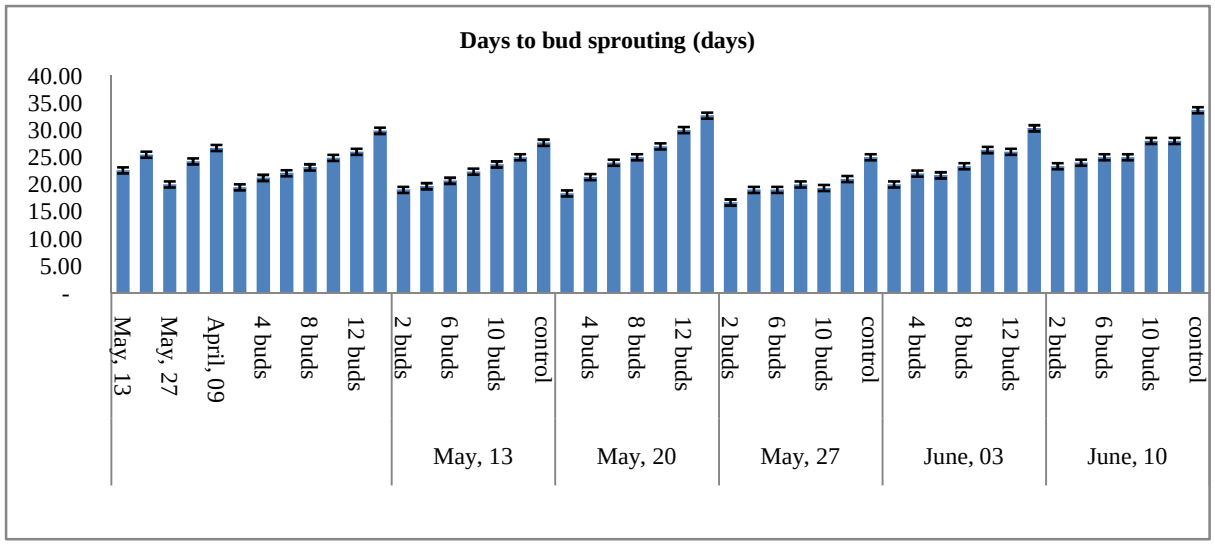

Fig. 1. Effect of level of pruning and pruning time on the day to bud sprouting of Ber cv. Seb.

As the pruning severity increased, early flowering and fruiting were observed (Fig. 2). Pruning of shoots leaving 2 buds resulted in precocious fruiting in 128.67 days followed by in shoots pruned leaving 4 buds (129.93 days) however, very late fruiting (136.47 days) was recorded in shoots received no pruning. The fruiting is about delayed by 8 days in the control plants compare to severe pruning treatment (leaving 2 buds). Irrespective of the severity of pruning, the date of pruning significantly affects required days to fruit. The earliest pruning date *i.e.* 13 May resulted in the earliest fruiting as well *i.e.* on 23 September. While fruiting was delayed by 30 days when shoot pruning was delayed by 21 days *i.e.* 03rdJune compare to early pruning (13 May). On the contrary, if pruning is delayed further (10thJune), thence time taken to fruit was reduced by 17 days, compared to early

pruning done on 13thMay. Among the treatment combinations, the earliest fruiting was observed on 11 September in the trees pruned on 13thMay leaving 2 buds in the shoots. Similarly in an experiment by Kumar *et al.* (2014), early bud sprouting (20.50 days) was recorded with severe pruning treatment (60% pruning of previous year shoot growth), compared to control (35.00 days) and the light pruning intensity (10% shoot pruning; 26.75 days). About 28 days advance in bud sprout was recorded in early pruned trees (13th May) compare to late pruning (10thJune). Devi and Babu (1993) also reported the advancement of bud sprouting in severe pruning. They also reported that early pruning of shoots (April) resulted in early bud sprouting. Similar to the advancement of day to sprouting under the severe pruning treatment, about one week early flowering and fruiting was recorded with severe pruning (leaving 2 buds), compare to light pruning (leaving 12 buds) and control treatment. Likewise, initiation of fruiting was started on 23rd September in the trees pruned on 13thMay and fruiting was delayed by a month (23rd October) when pruning was carried out on 3rd June. Sandhu *et al.*, (1992) reported about 24 days advance flowering in ber trees when the pruning was early on 1stMay compare to late pruning done on 28th July. Further, several studies found delayed flowering and fruiting as a result of delayed pruning (Kundu, 1994). Similarly, in Kinnow (*Citrus reticulata*) plants, pruning resulted earlier shoot emergence as compared to unpruned trees and it was recorded earliest in severely pruned trees (Dhaliwal *et al.*, 2014).

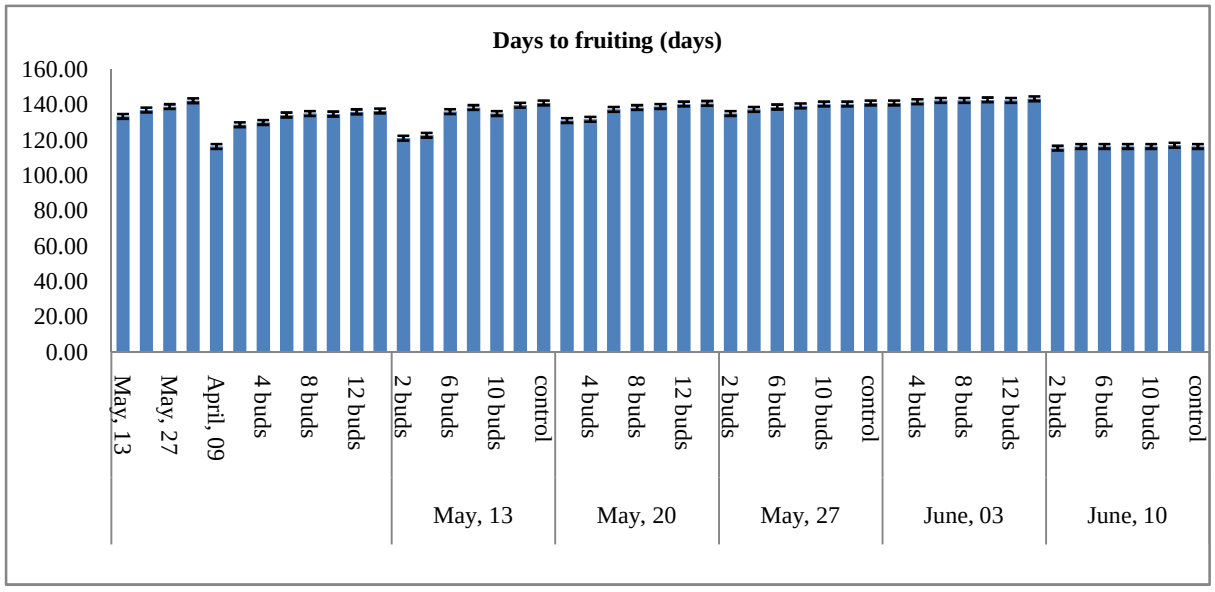

Fig. 2. Effect of Level of Pruning and Pruning Time on the days to fruiting of Ber cv. Seb.

A higher fruit set (%) was recorded with the light pruning treatment and control (Fig. 3). In severe and moderate pruning treatment (2 to 8 buds) comparatively lesser fruit set (12.07 to 13.56%) was observed. While, the light pruning by leaving 12 buds resulted in maximum fruit setting (15.48%), which was significantly higher than other pruning treatments and at par with the fruit set in control trees (14.52%). Time of pruning also affects the fruit set percentage and the maximum fruit set (17.38%) was recorded when the trees pruned on 20thMay. Whereas, minimum fruit (10.60%) set was noted on the trees pruned late *i.e.* 03rdJune. The interaction between pruning severity (leaving 6 buds) and pruning time (20thMay) resulted in a maximum fruit set (19.97%).

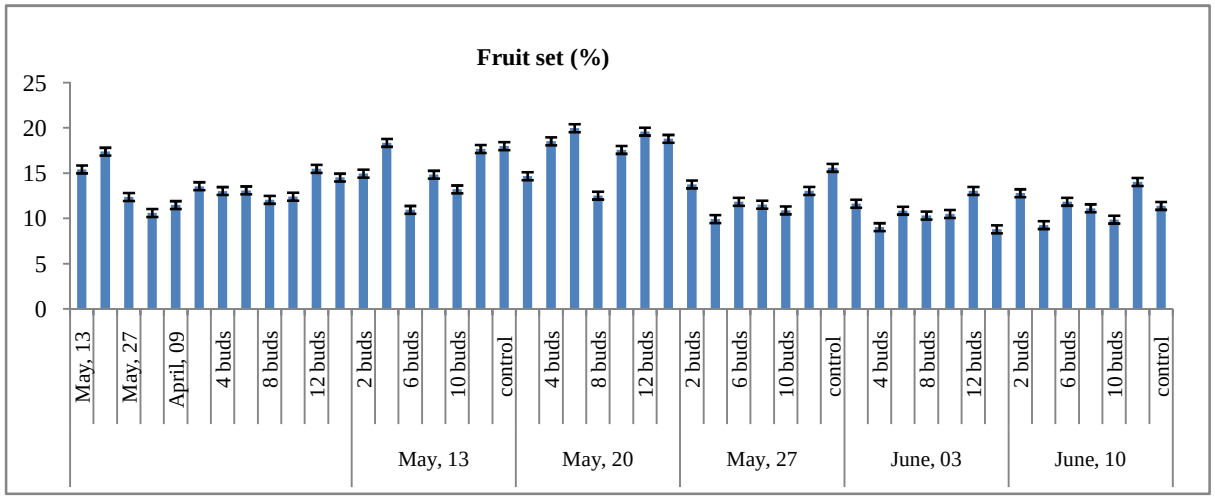

Fig. 3. Effect of Level of Pruning and Pruning Time on the Fruit set (%) of Ber cv. Seb.

The time and intensity of shoot pruning significantly influence the fruit yield traits like fruit diameter, length, and fruit weight as presented in Fig. 4-5. Among the pruning treatment, severe pruning of shoots yielded good size fruits, and maximum fruit diameter in the trees was pruned leaving 4 buds (23.39 mm) and 2 buds (23.32 mm) and minimum in the trees left un-pruned (20.75 mm). Early pruning of shoots during May (13th May) resulted in bigger size fruit particularly tree pruned on 13th May produce maximum fruit diameter (23.75 mm) followed by in tree pruned on 20th May (22.59 mm) and significantly minimum fruit diameter was noted in the shoots pruned late *i.e.* 10th June. Interaction between pruning time and severity indicated that severe pruning (leaving 2 buds) in May (13th May) was yielded fruits with a maximum diameter (26.86 mm) than the light pruning treatment (12 buds) on 10th June (17.83 mm). The result of the pruning treatments showed that moderate pruning upto 6 buds treatment positively affects the fruit length, however, further, decrease in the pruning severity, fruit length decreases significantly. Maximum fruit length was noted on the shoots pruned leaving 4 buds (24.07 mm), followed by leaving 6 buds (23.73 mm) and the minimum was recorded on the shoots pruned leaving 12 buds (21.13 mm) and control plants (21.16 mm). The time of pruning indicated the delayed pruning is not beneficial for the fruit growth and length of fruit is decreased, on the trees pruned in the late June (10th June) compare to tree pruned in the early May. The maximum length of fruits (23.72 mm) was recorded when the trees were on 13th May and the least fruit length (21.21 mm) was recorded when the trees were pruned on 10thJune. Among the interaction treatment, the longest fruit (28.17 mm) was reported in trees pruned on 13thMay leaving 6 buds on the shoots and the minimum length of fruits was noted in control trees (20.06 mm) of 10thJune treatment.

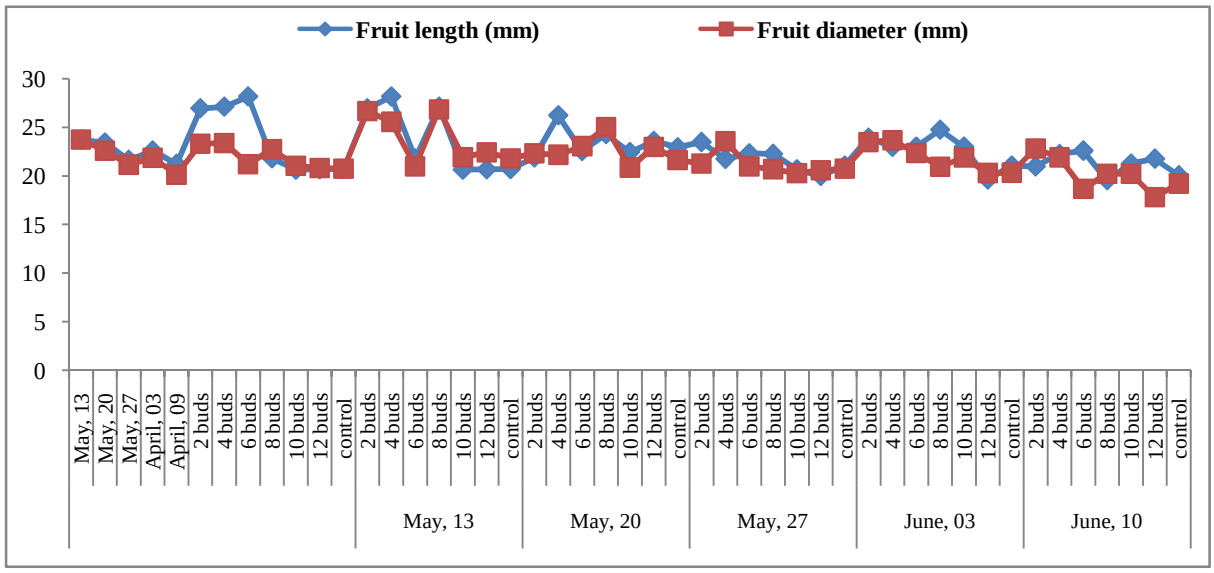

Fig. 4. Effect of Level of Pruning and Pruning Time on the Fruit length and diameter of Ber cv. Seb**.**

The average weight of fruit varied significantly in the different pruning treatments (Fig. 5). However, significantly higher individual fruit weight was observed in the trees pruned leaving 6 buds (6.33 g) and 4 buds (6.58 g) and decreased under the light pruning treatments. Pruning of the tree leaving 6 to 12 buds does not make any significant difference in the fruit weight among them. The minimum weight of fruit (4.30 g) was recorded in the control trees. Among the pruning time experiment, early pruning (13thMay) positively increase the fruit weight to the maximum extent (6.33 g) and late pruning (10thJune) decreases the fruit weight (4.87 g) significantly. Whereas the interaction between pruning severity and pruning time resulted in maximum fruit weight (5.99 g) in the trees pruned on 13 May leaving 4 buds and minimum fruit weight (3.64 g) in control tree of 03rdJune. In the same line, Kundu (1994) obtained maximum fruit set and fruit retention by pruning half of the primary branches keeping 15 buds on the shoot on 30th May. However, Gupta *et al.* (1990) reported that moderate pruning on 30th May was beneficial for higher fruit set and fruit retention in ber. Early pruning in May (20thMay) was beneficial for a higher fruit set. As delayed pruning in June declined the fruit set by 6.7%. Similarly, a significantly higher fruit set was reported by Sandhu *et al.*, (1992) in the trees pruned in May (30th May) than trees pruned late in June (14th June) and it further declined to the lowest level in the trees pruned very late on 28th July. The finding of the present investigation indicated that with an increase in pruning severity, the fruit size (length × diameter) increased up to 6 buds and thereafter it decreased and found minimum in the trees left un-pruned. Similarly, early pruning of shoots during May resulted in bigger size fruit (length × diameter) and significantly minimum fruit diameter and the length was noted in the shoots pruned late in June. Singh *et al*., (2004) also obtained similar results that with the severity of pruning the size of fruits increased and reached a maximum in 8 buds level. They postulated this increase in fruit size might be due to lesser competition for assimilates among fruits and better nutrient availability per fruit. Similarly, higher fruit weight and size were recorded in the tree pruned in May.

The pruning of trees during their complete dormancy could result in to increase in vigour of the pruned shoots thence an increase in fruit size (Kundu *et al.*, 1995). On the contrary, in the delayed pruning of shoots, fruits growth and development were affected due to shorting of the period from flowering to fruit maturation which could ultimately hamper the size of fruits. Higher fruit weight was observed in the trees pruned with moderate intensity (4-6 buds) and decreased under the light pruning treatments (8-12 buds) and reached a minimum under control trees. These results conform to the findings of Gill and Bal (2006) in ber. Gill and Bal (2006) reported maximum fruit weight in the trees pruned with medium intensity (leaving6 buds) and decreased at lower severity and control treatment. This is possibly due to less competition among the fruits as a lesser number of fruits retained in

severe and moderate pruning on trees so the metabolites availability per fruit increased. Among the pruning time experiment, early pruning (13thMay) positively increase the fruit weight to the maximum extent and late pruning (10thJune) decreases the fruit weight. Similarly, early pruning (9thMay) was found beneficial to produce heavier ber. While in the late pruning on 6thJune fruit weight was decreased. As trees pruned early were incomplete dormancy and probably owing to the dormant shoots becoming a better source for metabolites and nutrients (Gill & Bal, 2006). Moringa flowering and bud initiation were positively affected due to moderate pruning of the shoots (du Toit *et al.*, 2020).

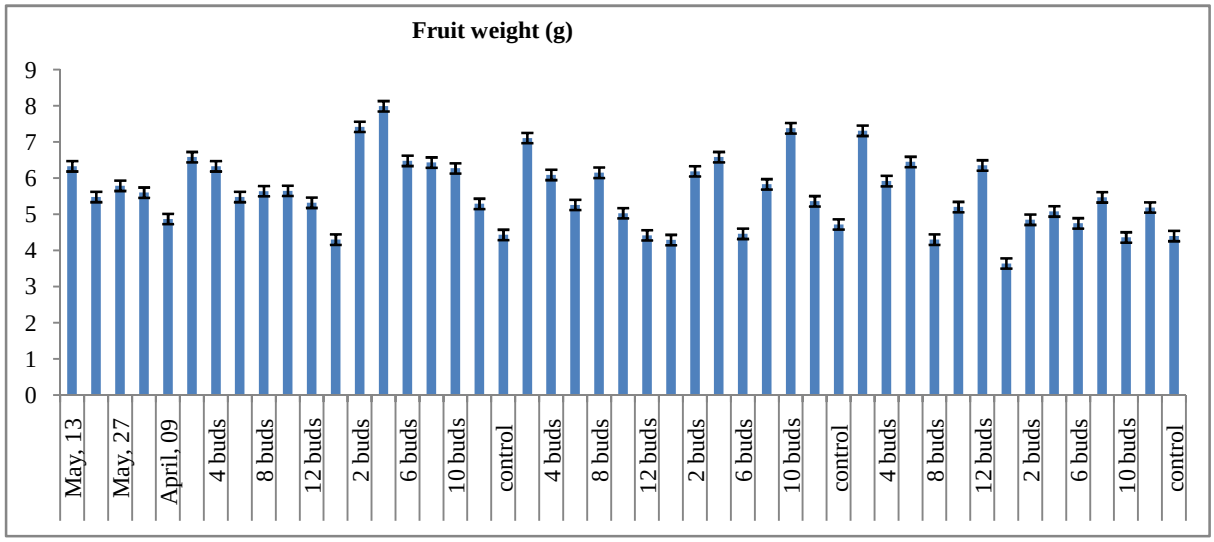

Fig. 5. Effect of Level of Pruning and Pruning Time on the Fruit weight (g) of Ber cv. Seb.

The fruit TSS (°B) increased significantly with a decrease in pruning severity up-to-the 6 buds, and it decreased in light pruning treatment and the lowest value was recorded in trees pruned leaving 12 buds (27.57 °B) and control plants (25.58 °B). The maximum fruit TSS was found in the fruits produced in trees pruned leaving 6 buds (30.37 °B) and 4 buds (29.87 °B). Similarly, maximum TSS (30.64 °B) was recorded in the tree pruned in late May (27th May) and minimum in the trees which pruned early *i.e.* 13th May (27.38 °B) and late *i.e.* 10thJune (28.13 °B). Further, the interaction of pruning time and severity resulted in maximum fruit TSS (35.12 °B) when trees were pruned on 27th May by leaving 2 buds (Fig. 6). Concurrent results were reported by Adhikari and Kandel (2015), who reported that quality concerning TSS of the Guava fruit increased with the increased level of pruning irrespective of the timing of pruning. As severely pruned trees bear fewer fruits per shoot favour diversion of more assimilate per fruit. Hence, fruit TSS content improved in the severely pruned tree. Generally, the fruit quality in terms of total soluble solids improved as the amount of pruning was increased. Gupta and Gill (2015) also supported that, TSS content increases with the increasing pruning severity, and the minimum was in control. Whereas, Kundu *et al.*, (1995) observed that pruning of shoots in May (30th May) produced maximum total soluble solids in fruit.

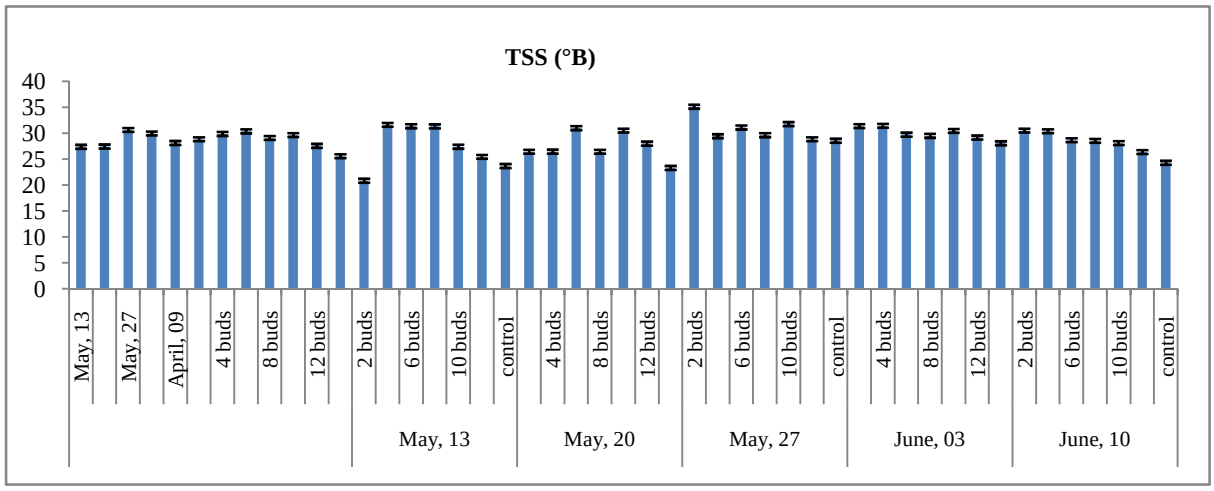

Fig. 6. Effect of Level of Pruning and Pruning Time on the Fruit total soluble solids (°B) of Ber cv. Seb.

Based on the findings of the experiment, it can be summarized that moderate pruning up to the 6 buds on 20th May, enhanced the fruit yield and fruit quality of Ber under the arid Kachchh conditions. The ber tree is summer deciduous and bears fruits on the new shoots, therefore the plants respond positively to the pruning exercise. Trees are in deep dormancy during summer (May)

and during this period shoots have a high level of metabolites (carbohydrates, starch, and sugars). Therefore, moderate pruning leads to the transfer of these reserves for higher fruit set, yield and greater fruit quality.

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