Reliable Physical Parameters for Determining Fruit/Seed Maturity Timing of *Ficus semicordata* Buch. in Kumaun Region of Central Himalaya

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Abstract
Wild edible plants play an important role as food supplements during scarcity for local inhabitants. *Ficus semicordata* is commonly known as drooping fig. Plant parts are used for medicinal purposes. It is a common agroforestry tree in the Himalayan region growing from 750 to 1500 m elevation. The present study was carried out to assess the exact time of seed and fruit maturation and germination of *F. semicordata* in Nainital district of Kumaun Himalaya across 3 sites during two consecutive years 2017 and 2018. Fruit of *F. semicordata* were collected from the marked trees from all the sites till the availability of the fruits. Across all the sites the mean fruit size varied between 190.24 ± 0.46 and 395.14 ± 3.56 mm² in Yr-1 and 135.56 ± 3.69 to 516.86 ± 1.26 mm² in Yr-2. Across both the sites the colour change from green to pinkish brown appears as one of the indicator of maturity. In addition to the colour fruit moisture content between 50.25±0.58% and 62.73±2.30% coincided with maximum germination (48.0±0.06% and 85± 4.61%).

Introduction
*Ficus semicordata* -Ham. ex Sm. (*syn. Ficus cunia* Buch.-Ham. ex Roxb.) is a multipurpose tree species belonging to the family Moraceae commonly known as Drooping fig, which is a small to medium sized tree up to 15 m tall, with an uneven crown. The leaf blade is frequently elliptic to lance-shaped and leaf margin is entire or coarsely toothed.1 *F. semicordata* usually evergreen tree. Sometimes leafless in the dry season.2 Flowering occurs between in the month of May-June. It produced the main seed crop in the beginning of rainy season.3 It occurs at the 750-1500 m elevation range in Himalayan region.4 The leafless fruit-bearing branches develop at the base of the trunk and often become stolon like, trailing across the forest floor.5 Young fruits and whole parts of the tree are used as a medicine. It is a potential fodder for goat and cattle.6 The leaves are also used for polishing wood, ropes are made in by the fibre of bark and species is important for agroforestry.6
Seed maturity is often supplemented by recognizable change in colour, size, odour, taste and texture of the fruits and seeds. Maximum seed quality is reached when seeds get maximum dry weight. Though in certain other species seed quality is reached sometime after achieving maximum dry weight.\(^7\)

\textit{Ficus} species are grown in different habitats, the seeds were positively photoblastic. The germination of some \textit{Ficus} species is stimulated by light and inhabited by gloom. Germination is the conversion form of seed to seedling in the life cycle of plants. The regeneration of most of the wild edible and multipurpose species is poor in their natural habitats mainly due to intense biotic pressure on them.\(^8\) To synchronize the artificial regeneration of this important trees species an exact knowledge of maturity time is essential to avoid collection of immature and non-viable seeds.\(^9\) Collection of forest fruits and seeds are greatly helped by reliable guidelines of maturity that allow earliest possible collection. In many Himalayan species seed maturation has been related to physical parameters but there is scanty information on seed maturation of \textit{F. semicordata}. The objective of present study was to evaluate the exact time of fruit/seed maturation and germination behaviour of \textit{F. semicordata}.

**Material and Methods**

**Study Site**
The study area lies between 29°18' N latitude and 79°30' E longitude. The study was carried out in Nainital district during two consecutive years 2017 and 2018. After a thorough survey 3 sites were selected between 1100 and 1622m elevation on north-western aspect. \textit{Bombax ceiba}, \textit{Eucalyptus} species, \textit{Pinus roxburghii}, \textit{Cinnamomum tamala}, \textit{Celtis iguancea} and \textit{Ficus hispida} were common associated species across all the sites. Climate of study sites is subtropical monsoon type with high temperature towards lower elevation and lower temperature towards high elevation. Annual rainfall was 1679.31-1570.34 mm during 2017-2018, of which nearly 85% occurred during the monsoon period (June to Sep). In both years June was the warmest month and January the coldest one, with temperature varied between 9 and 25°C.\(^10\)

**Vegetational Parameters**
The vegetation analysis was made by placing 10 quadrates of 10 sqm across each site. The density of trees, saplings and seedlings were calculated following.\(^11\)

**Tree Characteristics**
Five average sized healthy trees were selected and marked at a distance of about 100m from each other at each site. The tree height was measured with Ravi multimeter and tree circumference at breast height (CBH) was measured with a meter tape. The mean tree height ranged between 6.78±1.02 and 14±1.42 m. The mean CBH ranged between 65.71±5.24 and 1.21±9.33 cm.

**Maturity Indices**
Fruits were collected at 1-week intervals directly from the marked trees. Fruits of all trees at one collection date were mixed and a composite sample was made. From the composite sample three replicates of 25 fruits/seeds were taken for determining different physical characters of fruits/seeds (colour, size, fresh weight). Fruit and seed weight (100 fruits/seeds) was measured using electronic balance (Model No. PGB 301 accuracy + 0.001mg Wensar), Length and width of fruits and seeds were measured by digital Vernier calliper (Model No. CD-6” accuracy + 0.02mm Mitutoyo Co.). Moisture content percentage was calculated for each collection using three replicates of 25 fruit/seed, and estimated on fresh weight basis by drying at 103±2° C for 16±1 hr, then each sample was reweighted following.\(^12\)

**Germination**
For germination 4 replicates of 100 seeds were kept at the top of germination paper in petri-dishes at room temperature. During the study period the daily room temperature ranged between 10°C and 28°C. Germination was recorded when the radicle began to appear and monitored for 40 days. Germination percentage was calculated following.\(^13\) The data were statically analysed using Analysis of Variance (ANOVA) to determine difference in fruit/seed characteristics, moisture content and germination.\(^14\)
Table 1: Description of study sites of *F. semicordata*  
(Abbreviation- NW = Northwest, SI, SII, SIII = sites)  

| S No. | Sites | Altitude | Coordinates         | Aspect | Associated species                                                                 | Density (ind./ha) |
|-------|-------|----------|---------------------|--------|-------------------------------------------------------------------------------------|-------------------|
| 1     | SI    | 1622 m   | 29° 20' N, 79° 26' E | NW     | *Pinus roxburghii, Ficus clavata, F. roxburghii*                                     | 156               |
| 2     | SII   | 1100 m   | 29° 19' N, 79° 29' E | NW     | *Eucalyptus species, Pinus roxburghii, Bombax ceiba*                                | 133               |
| 3     | SIII  | 1250 m   | 29° 23' N, 79° 29' E | NW     | *Celtis iguancea, Cinnamomum tamala, Bombax ceiba, Ficus hispida*                   | 122               |

Results and Discussion  
Vegetational Analysis

In the study area the distribution of *F. semicordata* was found along village paths associated with *Pinus roxburghii*, *Eucalyptus* species and *Bombax ceiba*. Across all the sites the tree density of *F. semicordata* ranged from 122 to 156 ind/ha. The maximum density 156 ind/ha was in site one (SI) (Table 1). The sapling density of the species varied between 44 and 56 ind/ha and seedling density ranged from 33 to 44 ind/ha.

Fruit/Seed Characteristics

Across all the sites the fruit colour was green at first collection during II week of May and gradually turned to pinkish-brown at final collection during last week of June (Tables 2, 3). The seeds were immature during the first and second collection in both the years.

Fruit and Seed Size

In Yr1, across all the sites and dates of collection the average fruit length varies between 13.37±0.04mm (S II) and 19.18±0.03mm (S III) and the fruit width ranged between 14.22±0.06mm (S II) and 20.60±0.17 (S III). The average seed length varies between 1.00±0.03mm (S I) and 1.63±0.07mm (S III) and the seed width ranged between 0.83±0.03mm (S III) and 1.11±0.03mm (S II) (Table 2).

In Yr 2, across all sites and dates of collection the average fruit length varies between 11.46±0.19mm (S III) and 20.44±0.47mm (S III) and the fruit width ranged between 11.82±0.16mm (S III) and 25.90±0.015 (S II). The average seed length varies between 1.21±0.08mm (S III) and 2.23±0.03mm (S I) and the seed width ranged between 1.03±0.03mm (S III) and 1.54±0.09mm (S III) (Table 3). ANOVA showed that the fruit size varied significantly across the dates, sites and years (P<0.05). The seed size varied significantly across the dates, sites and years (P<0.05). The interactions between year x date, year x site, date x site were significant for both fruit and seed size (P<0.05) (Table 4).

Fruit and Seed Weight

In Yr 1 across all sites and dates the weight of 100 fruits ranged between 181.92 ± 1.34 to 399.00 ± 2.65 g and weight of 100 seeds 0.05±0.003 to 0.18± 0.01 g (Table 2). In Yr 2 the weight of 100 fruits ranged from 123.37 ± 0.68 to 522.02 ± 1.52g and weight of 100 seeds from 0.05± 0.01 to 0.36 ± 0.02 g (Table 3). ANOVA showed that the weight of fruit varied significant across dates, sites, and years (P<0.05). The seed weight varied significantly across the dates and sites (P<0.05). The interaction between year x date, year x site, date x site, year x date x site was significant for both fruit and seed weight (P< 0.05) (Table 4).

Number of Fruit and Seeds per 100 g

In Yr 1 the number of fruits in 100 g varied between 20.00 ± 1.15 and 83.33 ±3.33 and the number of seeds in 100g varied from 79,410.00 ± 5.77 to 82,117.00 ± 3.61 (Table 2). In Yr 2 the number of fruits per 100g ranged from 20.67 ±0.67 to 108.33 ± 1.20 and the seeds per 100g varied between 67,902.00 ± 2.00 to 97,420.67 ± 4.67 (Table3). The number of fruits/seeds in 100 g decreased as the fruit/ seed size and weight increased. ANOVA showed that the number of fruits and seeds in 100 g varied significantly across the dates and years (P<0.05). The interaction between year x date, year x site, date x site, year x date x site were significant for both fruit and seed (P< 0.05) (Table 4).
Table 2: Changes in physical fruit and seed characteristics and germination in *F. semicordata* across different collection dates YR-1  
(Abbreviation – Im = Seeds were immature inside the fruit, G = Green, YB = Yellowish brown, PB = Pinkish brown)

|         | Fruit characteristics | Seed characteristics |
|---------|-----------------------|----------------------|
|         | Fruit Size (mm)       | Seed Size (mm)       |
|         | Length Width (g)      | Weight of Number of |
| Site    | 100 fruits Moisture  | 100 seeds Moisture  |
| Collection date | (%) | (%) |
| S1      | 14-05-17 G 13.96±0.22 14.31±0.12 186.03±8.26 66.67±6.67 | 83.55±1.94 Im Im Im Im Im Im |
|         | 21-05-17 G 15.53±0.24 16.20±0.05 188.47±5.32 60.00±5.77 | 75.47±1.86 0.69±0.03 0.69±0.03 0.05±0.03 81907.00±3.51 67.67±3.03 0.00±0.00 |
|         | 28-05-17 G 15.53±0.25 16.45±0.10 217.67±2.61 46.67±3.33 | 71.35±3.43 1.17±0.01 0.84±0.02 0.07±0.02 82413.33±8.82 62.29±2.46 6.02±0.06 |
|         | 04-06-17 G 16.46±0.14 17.14±0.02 300.43±5.93 43.33±3.33 | 69.29±2.46 1.12±0.04 0.94±0.02 0.08±0.02 83907.00±3.51 61.12±0.81 31.00±0.11 |
|         | 11-06-17 YB 16.88±0.06 17.78±0.22 336.33±4.26 33.33±3.33 | 66.55±0.88 1.16±0.10 0.93±0.04 0.12±0.01 81518.67±4.37 60.03±0.75 35.75±0.31 |
|         | 18-06-17 YB 17.07±0.04 18.13±0.24 339.67±1.86 26.67±3.33 | 60.94±0.71 1.17±0.01 0.84±0.02 0.07±0.02 80226.67±8.82 52.92±0.37 46.00±0.49 |
|         | 25-06-17 PB 18.10±0.00 19.08±0.02 356.00±2.08 23.33±3.33 | 56.54±0.88 1.26±0.03 1.04±0.05 0.18±0.01 79410.00±5.78 46.90±0.66 56.02±0.50 |
| S2      | 14-05-17 G 13.37±0.04 14.22±0.06 183.27±2.13 83.33±3.33 | 81.17±0.59 Im Im Im Im Im Im |
|         | 21-05-17 G 14.14±0.01 15.56±0.10 184.01±5.52 70.00±5.77 | 77.92±0.54 0.94±0.09 0.57±0.04 0.09±0.01 82117.00±3.61 68.64±2.57 12.25±0.10 |
|         | 28-05-17 G 14.67±0.04 16.00±0.00 186.70±3.72 63.33±3.33 | 75.19±0.55 0.70±0.02 0.81±0.04 0.11±0.01 82442.67±1.45 68.36±2.36 29.75±0.49 |
|         | 04-06-17 G 16.85±0.07 17.25±0.05 292.04±1.53 354.39±2.02 | 36.67±3.33 14.90±0.14 0.82±0.02 0.14±0.01 84350.33±8.98 54.67±0.55 41.75±0.92 |
|         | 11-06-17 YB 18.17±0.03 19.48±0.23 354.39±2.02 36.67±3.33 | 62.53±1.45 0.90±0.01 0.82±0.02 0.14±0.01 83722.33±1.45 66.95±0.84 40.25±0.16 |
|         | 18-06-17 YB 18.35±0.09 19.92±0.07 366.84±1.49 33.33±3.33 | 55.23±2.63 1.09±0.04 0.93±0.04 0.17±0.01 81114.00±1.53 40.45±0.46 44.00±0.58 |
|         | 25-06-17 PB 18.25±0.12 20.63±0.06 379.13±2.13 26.67±3.33 | 50.25±0.58 1.14±0.06 1.11±0.04 0.18±0.01 80802.67±1.77 40.34±0.74 48.00±0.06 |
| S3      | 14-05-17 G 13.46±0.08 14.68±0.01 181.92±1.34 76.67±3.33 | 82.78±1.63 Im Im Im Im Im Im |
|         | 21-05-17 G 14.68±0.07 14.82±0.03 182.77±7.16 66.67±3.33 | 85.48±0.21 1.00±0.04 0.83±0.03 0.09±0.01 81802.67±1.77 67.99±0.75 0.00±0.00 |
|         | 28-05-17 G 15.15±0.13 15.52±0.19 190.71±3.35 56.67±3.33 | 84.72±0.33 1.12±0.02 0.82±0.03 0.09±0.03 81304.67±2.19 67.94±0.33 0.25±0.01 |
|         | 04-06-17 G 16.57±0.24 16.46±0.14 290.64±1.93 46.67±3.33 | 75.63±0.83 1.31±0.11 0.75±0.04 0.11±0.01 81160.00±2.31 63.30±1.68 4.05±0.07 |
|         | 11-06-17 YB 17.50±0.27 17.70±0.09 317.76±6.18 43.33±3.33 | 71.23±0.59 1.09±0.04 0.93±0.03 0.12±0.01 80505.00±2.65 61.55±1.33 36.05±0.03 |
|         | 18-06-17 YB 18.40±0.15 19.73±0.29 367.17±6.87 26.67±3.33 | 62.73±2.30 1.22±0.09 0.89±0.08 0.17±0.01 80216.33±2.96 58.55±0.88 54.00±0.58 |
|         | 25-06-17 PB 19.18±0.03 20.60±0.17 399.00±2.65 20.00±1.16 | 54.37±1.39 1.63±0.07 1.07±0.04 0.18±0.01 79710.67±0.89 46.91±1.22 53.25±0.25 |
Table 3: Changes in physical fruit and seed characteristics and germination in *F. semicordata* across different collection dates YR-2

(Abbreviation – Im = Seeds were immature inside the fruit, G = Green, YB = Yellowish brown, PB = Pinkish brown)

| Site | Collection Date | Fruit characteristics | Seed characteristics |
|------|----------------|-----------------------|---------------------|
|      |                | Fruit Size (mm)       | Number of Moisture | Seed Size (mm)       | Weight of Moisture |
|      |                | Length Width          | Weight of fruit in 100g (%) | Length Width | Weight of seeds in 100g (%) | (%) |
| S1   | 14-05-18       | 12.80±0.09 13.94±0.03 | 158.42±0.70 108.33±1.20 79.44±1.53 | Im | Im |
|      | 21-05-18       | 13.10±0.15 14.11±0.11 | 179.70±2.30 93.33±1.76 75.47±1.86 | Im | Im |
|      | 28-05-18       | 14.29±0.19 15.20±0.41 | 234.42±6.06 73.33±3.33 71.35±3.43 | 1.33±0.06 1.12±0.07 | 97420.67±4.67 | 67.67±3.04 | 1.75±0.10 |
|      | 04-06-18       | 16.52±0.05 17.62±0.58 | 315.29±0.53 46.67±3.33 68.35±1.19 | 1.54±0.12 | 1.24±0.01 | 0.09±0.003 | 81665.33±1.45 | 62.29±2.45 | 26.75±0.53 |
|      | 11-06-18       | 17.37±0.11 19.34±0.39 | 353.08±1.94 36.67±3.33 64.15±2.20 | 1.63±0.17 | 1.24±0.08 | 0.10±0.003 | 80314.67±3.71 | 59.58±0.54 | 48.80±0.57 |
|      | 18-06-18       | 19.64±0.29 24.88±0.30 | 485.08±2.85 26.67±3.33 57.49±1.90 | 1.70±0.08 | 1.31±0.08 | 0.11±0.003 | 75412.67±1.76 | 52.78±0.47 | 50.75±1.76 |
|      | 25-06-18       | 19.66±0.02 25.00±0.39 | 510.28±3.60 28.33±1.20 53.18±1.61 | 2.23±0.03 | 1.43±0.05 | 0.15±0.003 | 73602.33±1.45 | 48.15±0.52 | 65.57±2.20 |
| S2   | 14-05-18       | 13.12±0.17 13.65±0.07 | 164.98±2.01 94.67±0.88 | 81.17±0.59 | Im | Im |
|      | 21-05-18       | 14.43±0.05 15.41±0.05 | 169.37±1.39 82.00±1.53 | 77.92±0.54 | 1.26±0.03 | 1.16±0.01 | 0.09±0.003 | 97003.67±1.86 | 68.64±2.57 | 1.05±0.15 |
|      | 28-05-18       | 16.70±0.01 18.20±0.04 | 318.17±3.22 74.48±1.27 | 1.56±0.01 | 1.16±0.05 | 0.10±0.003 | 96105.00±2.89 | 66.95±0.84 | 13.25±0.32 |
|      | 04-06-18       | 18.11±0.00 19.67±0.21 | 374.45±3.05 52.00±1.53 | 71.48±1.47 | 1.55±0.03 | 1.25±0.06 | 0.13±0.006 | 92716.33±2.96 | 63.99±1.19 | 27.05±1.81 |
|      | 11-06-18       | 18.34±0.27 19.56±0.26 | 382.06±1.20 45.00±2.65 | 66.28±2.11 | 1.81±0.16 | 1.22±0.05 | 0.13±0.006 | 84103.33±2.85 | 60.31±5.74 | 51.08±0.44 |
|      | 18-06-18       | 19.79±0.05 25.63±0.20 | 510.70±2.99 31.67±1.67 | 56.67±2.77 | 2.05±0.08 | 1.39±0.01 | 0.14±0.007 | 75412.67±1.76 | 52.78±0.47 | 76.92±1.90 |
|      | 25-06-18       | 19.96±0.07 25.90±0.05 | 522.02±1.52 24.33±2.96 | 50.35±0.94 | 2.19±0.11 | 1.54±0.08 | 0.15±0.006 | 67902.00±2.00 | 44.67±0.35 | 83.05±1.67 |
| S3   | 14-05-18       | 11.46±0.19 11.82±0.16 | 123.37±0.68 102.33±1.86 | 82.78±1.63 | Im | Im |
|      | 21-05-18       | 11.92±0.26 12.50±0.15 | 132.27±0.64 93.33±3.28 | 81.08±0.52 | Im | Im |
|      | 28-05-18       | 16.50±0.21 18.34±0.31 | 310.53±3.91 70.67±5.36 | 76.63±1.31 | 1.21±0.08 | 1.03±0.03 | 0.09±0.001 | 87322.67±1.20 | 70.84±1.32 | 16.75±1.92 |
|      | 04-06-18       | 19.05±0.03 19.57±0.10 | 391.87±2.54 63.67±2.91 | 73.15±1.54 | 1.63±0.02 | 1.13±0.03 | 0.12±0.001 | 86704.67±2.60 | 63.30±1.68 | 46.75±0.01 |
|      | 11-06-18       | 19.28±0.07 20.26±0.07 | 423.58±6.50 56.00±1.73 | 68.13±1.06 | 1.84±0.11 | 1.29±0.09 | 0.13±0.001 | 79753.67±1.86 | 61.94±2.18 | 56.48±1.84 |
|      | 18-06-18       | 20.84±0.07 23.44±0.27 | 512.60±4.30 33.67±1.86 | 54.15±0.63 | 1.96±0.06 | 1.31±0.07 | 0.15±0.001 | 75125.33±1.76 | 55.92±1.81 | 84.75±2.07 |
|      | 25-06-18       | 20.44±0.47 24.78±0.55 | 515.15±0.65 20.67±0.67 | 52.16±0.57 | 2.06±0.04 | 1.54±0.09 | 0.36±0.001 | 68009.00±4.58 | 52.51±0.95 | 85.00±4.61 |
Fruit and Seed Moisture Content

In Yr 1 across all the sites during first collection the fruit moisture content ranged between 81.17±0.59% and 83.55±1.94%. The fruit moisture content decline gradually with each collection at reached to 50.25±0.57% and 56.54±0.88 at final collection. In all the sites the seeds were immature during the first collection. The moisture content of seeds at second collection ranged between 67.67±3.03% and 68.64±2.57% and at final collection the seed moisture content varied between 40.34±0.74% and 46.91±1.22% (Table 2). In Yr 2 across all the sites during first collection the fruit moisture content ranged between 79.44±1.53% and 82.78±1.63%.

The fruit moisture content decline gradually with each collection at reached to 50.35±0.94% and 53.18±1.60% at final collection. In SI and SII sites the seeds were immature during the first collection and in SIII site the seeds of first two collection were immature. The initial moisture content of seeds ranged between 67.67±3.04% and 70.84±1.31% and at final collection the seed moisture content varied between 44.67±0.36% and 52.51±0.95% (Table 3). ANOVA showed that the fruit and seed moisture content percent varied significant across dates, sites and years (P<0.05). The interaction between year × site was significant P<0.05) (Table 4).

Table 4: Analysis of variance (ANOVA) for different fruit and seed parameters across different collection dates, sites and years

| Characters          | Source         | Type III Sum of Square | df | Mean Square | F-Value |
|---------------------|----------------|------------------------|----|-------------|---------|
| Fruit Length (mm)   | Year           | 8.711                  | 1  | 8.711       | 114.346 ** |
|                     | Site           | 7.869                  | 2  | 3.934       | 51.644 ** |
|                     | Date           | 649.141                | 6  | 108.190     | 1.420 ** |
|                     | Year × Site    | 5.198                  | 2  | 2.599       | 34.114 ** |
|                     | Year × Date    | 52.704                 | 6  | 8.784       | 115.304 ** |
|                     | Site × Date    | 21.092                 | 12 | 1.758       | 23.072 ** |
|                     | Year × Site × Date | 22.267               | 12 | 1.856       | 24.358 ** |
| Fruit width (mm)    | Year           | 100.125                | 1  | 100.125     | 700.076 ** |
|                     | Site           | 18.018                 | 2  | 9.009       | 62.990 ** |
|                     | Date           | 1234.901               | 6  | 205.817     | 1.439 ** |
|                     | Year × Site    | 1.951                  | 2  | .976        | 6.822 ** |
|                     | Year × Date    | 202.050                | 6  | 33.675      | 235.455 ** |
|                     | Site × Date    | 17.505                 | 12 | 1.459       | 10.200 ** |
|                     | Year × Site × Date | 40.968                | 12 | 3.414       | 23.870 ** |
| Weight of 100 Fruits (g) | Year       | 8020.379               | 1  | 8020.379    | 176.231 ** |
|                     | Site           | 769.834                | 2  | 384.917     | 8.458 ** |
|                     | Date           | 2012197.933            | 6  | 335366.322  | 7.369 ** |
|                     | Year × Site    | 21445.400              | 2  | 10722.700   | 235.609 ** |
|                     | Year × Date    | 39510.083              | 6  | 6585.014    | 144.692 ** |
|                     | Site × Date    | 33042.826              | 12 | 2753.569    | 60.504 ** |
|                     | Year × Site × Date | 19937.341               | 12 | 1661.445    | 36.507 ** |
| Number of Fruits in 100g | Year       | 4299.175               | 1  | 4299.175    | 136.413 ** |
|                     | Site           | 473.190                | 2  | 236.595     | 7.507 ** |
|                     | Date           | 62666.937              | 6  | 10444.489   | 331.404 ** |
|                     | Year × Site    | 928.111                | 2  | 464.056     | 14.725 ** |
|                     | Year × Date    | 2793.603               | 6  | 465.601     | 14.774 ** |
|                     | Site × Date    | 868.921                | 12 | 72.410      | 2.298 ** |
|                     | Year × Site × Date | 1018.444               | 12 | 84.870      | 2.693 ** |
| Parameter | Main Factor | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 | Level 7 | Level 8 | Level 9 | Level 10 | Level 11 | Level 12 | Level 13 | Level 14 | Level 15 | Level 16 | Level 17 |
|-----------|-------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Fruit Moisture | Year | 81.008 | 1 | 81.008 | 11.232 | ** |
| Content % | Site | 446.844 | 2 | 223.422 | 30.977 | ** |
| Date | 12722.779 | 6 | 2120.463 | 293.998 | ** |
| Year × Site | 129.019 | 2 | 64.509 | 8.944 | ** |
| Year × Date | 32.888 | 6 | 5.481 | .760 | NS |
| Site × Date | 381.147 | 12 | 31.762 | 4.404 | ** |
| Year × Site × Date | 90.481 | 12 | 7.540 | 1.045 | NS |
| Seed Length | Year | 4.613 | 1 | 4.613 | 320.236 | ** |
| (mm) | Site | .172 | 2 | .086 | 5.967 | ** |
| Date | 39.034 | 6 | 6.506 | 451.585 | ** |
| Year × Site | 1.493 | 2 | .746 | 51.804 | ** |
| Year × Date | 5.833 | 6 | .972 | 67.477 | ** |
| Site × Date | 2.258 | 12 | .188 | 13.063 | ** |
| Year × Site × Date | 1.218 | 12 | .102 | 7.046 | ** |
| Seed Width | Year | 1.580 | 1 | 1.580 | 239.986 | ** |
| (mm) | Site | .161 | 2 | .080 | 12.212 | ** |
| Date | 21.175 | 6 | 3.529 | 536.007 | ** |
| Year × Site | .427 | 2 | .213 | 32.422 | ** |
| Year × Date | 2.081 | 6 | .347 | 52.676 | ** |
| Site × Date | .954 | 12 | .080 | 12.078 | ** |
| Year × Site × Date | 1.448 | 12 | .121 | 18.324 | ** |
| Weight of 100 | Year | .001 | 1 | .001 | 4.188 | ** |
| Seeds (g) | Site | .031 | 2 | .016 | 75.465 | ** |
| Date | .447 | 6 | .075 | 361.200 | ** |
| Year × Site | .005 | 2 | .003 | 12.496 | ** |
| Year × Date | .020 | 6 | .003 | 16.421 | ** |
| Site × Date | .050 | 12 | .004 | 20.125 | ** |
| Year × Site × Date | .043 | 12 | .004 | 17.311 | ** |
| Number of | Year | 1.608 | 1 | 1.608 | 2.498 | ** |
| Seeds in 100g | Site | 2.023 | 2 | 1.011 | 1.571 | ** |
| Date | 1.033 | 6 | 1.722 | 2.676 | ** |
| Year × Site | 1.527 | 2 | 7.635 | 1.186 | ** |
| Year × Date | 1.072 | 6 | 1.787 | 2.777 | ** |
| Site × Date | 7.732 | 12 | 6.444 | 1.001 | ** |
| Year × Site × Date | 8.047 | 12 | 6.706 | 1.042 | ** |
| Seed Moisture | Year | 798.186 | 1 | 798.186 | 97.594 | ** |
| Content % | Site | 336.968 | 2 | 168.484 | 20.601 | ** |
| Date | 56599.376 | 6 | 9433.229 | 1.153 | ** |
| Year × Site | 1141.845 | 2 | 570.922 | 69.807 | ** |
| Year × Date | 7532.546 | 6 | 1255.424 | 153.501 | ** |
| Site × Date | 5657.732 | 12 | 471.478 | 57.648 | ** |
| Year × Site × Date | 3628.854 | 12 | 302.404 | 36.975 | ** |
| Germination | Year | 2759.234 | 1 | 2759.234 | 490.398 | ** |
| % | Site | 1141.568 | 2 | 570.784 | 101.445 | ** |
| Date | 77967.463 | 6 | 12994.577 | 2.310 | ** |
| Year × Site | 1922.280 | 2 | 961.140 | 170.823 | ** |
| Year × Date | 3832.931 | 6 | 638.822 | 113.538 | ** |
| Site × Date | 1881.255 | 12 | 156.771 | 27.863 | ** |
| Year × Site × Date | 3265.532 | 12 | 272.128 | 48.365 | ** |
Germination Percent
In Yr1 at SI and SII sites the germination started from the third collection and in S II site from second collection. The initial germination ranged between 0.25±0.006 and 12.25±0.102%. The germination percentage increases with each collection and was maximum during the last collection. The maximum germination ranged between 48.00±0.06 and 56.02±0.50% (Table 2). In Yr 2 due to immature seeds the germination started from third collection in SI and SIII site and from second collection in SII site. The initial germination ranged between 1.05±0.15 and 16.75±1.9%. In Yr 2 also the maximum germination was during the last collection and was 65.57±2.20 and 85.00±4.60% (Table3). ANOVA showed germination percent varied significantly across the sites, dates and years (P<0.05) (Table 4).

Like all other Ficus species, F. semicordata is an overexploited tree species due to its medicinal uses in 16 states of India. The poor natural regeneration of most of the Ficus species has been reported in many studies though the regeneration of F. semicordota is comparatively better than the other species. But still the species requires attention for the future multiplication.

Physical characteristics of fruits/seeds have played significant role in determining the indices of seed maturity. Distinct colour change have been associated with seed maturity in many hardwood species. The fruit maturation of F. semicordata became apparent with the change in its colour from green to pinkish brown. Maximum germination occurred when the colour of fruit of F. semicordata turned to pinkish brown. Colour turned out to be a reliable indicator of maturity in many wild edible species like Myrica esculenta, Prunus cerasoides, Bauhinia retusa and Pyracantha crenulata. Moisture plays a critical role throughout the life of seeds, change in fruit and seed moisture content are strong manifestations that ripeness is progressing.

Decline in moisture content from maturing seeds is closely related to seed maturity. In F. semicordata also decline in moisture content was a good indicator of maturity. The seed matured when fruit moisture content ranged between 50.25±0.58% and 62.73±2.30% coincided with maximum germination (48.0±0.06% and 85± 4.61%). Similar results were also observed in other species of Ficus namely F. lundellii, F. microcarpa and F. krishnae. Casuarina equisetifolia also attain seed maturity when moisture content is below 50%. F. semicordata fruits/seeds attained maturity in the last week of June which is similar to the other species of Ficus like Ficus trigona, Ficus bolivia, Ficus auriculata, Ficus hispida.

Conclusion
From the present study it was evident that the change in fruit colour from green to pinkish brown appears to be a useful parameter for determining proper time of seed collection. In addition, moisture content of fruits and seeds is also a valuable parameter to infer the maturity stage and germination capability. The parameters can be used for collecting mature fruits/seeds and avoiding large scale nursery and plantation failures due to immature fruits/seeds of the species.

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Conflict of Interest
The authors do not have any conflict of interest.

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