

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 $50.25 \pm 0.58\%$ and $62.73 \pm 2.30\%$ coincided with maximum germination ($48.0 \pm 0.06\%$ and $85 \pm 4.61\%$).



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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.¹ The leaves are also used for polishing wood, ropes are made in by the fibre of bark and species is important for agroforestry.⁶

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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

Ficus species are grown in different habitats, the seeds were positively photoblastic. The germination of some *Ficus* species is stimulated by light and inhibited 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 *F. semicordata*. The objective of present study was to evaluate the exact time of fruit/ seed maturation and germination behaviour of *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. *Bombax ceiba*, *Eucalyptus* species, *Pinus roxburghii*, *Cinnamomum tamala*, *Celtis iguancea* and *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	S I	1622 m	29° 20' N, 79° 26' E	NW	<i>Pinus roxburghii</i> , <i>Ficus clavata</i> , <i>F. roxburghii</i>	156
2	S II	1100 m	29° 19' N, 79° 29' E	NW	<i>Eucalyptus species</i> , <i>Pinus roxburghii</i> , <i>Bombax ceiba</i>	133
3	S III	1250m	29° 23' N, 79° 29' E	NW	<i>Celtis iguancea</i> , <i>Cinnamomum tamala</i> , <i>Bombax ceiba</i> , <i>Ficus hispida</i>	122

Results and Discussion

Vegetational Analysis

In the study area the distribution of *F. semicordata* was found along village paths associated with *Pinus roxburghii*, *Euclayptus* 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 III) 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 sites and years (P<0.05). The interactions between year × date, year × site, date × 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× date, year × site, datex site, year × date × 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× date, year × site, datex site, year × date × 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)

Site Collection	Fruit colour	Fruit characteristics						Seed characteristics					
		Fruit Size (mm)		Weight of 100 fruits (g)	Number of fruit in 100g	Moisture content (%)	Seed Size (mm)		Weight of 100 seeds (g)	Number of seeds in 100 (g)	Moisture Content (%)	Germination (%)	
		Length	Width				Length	Width					
YR -1													
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±0.003	0.69±0.003	0.05±0.003	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	1.13±0.15	0.94±0.11	0.13±0.01	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±0.001	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	53.33±3.33	68.62±1.22	0.86±0.03	0.76±0.03	0.13±0.01	83722.33±1.45	66.95±0.84	40.25±0.16
	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	84350.33±0.89	54.67±0.55	41.75±0.92
	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±0.750	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±0.003	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	81106.00±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	Fruit colour	Fruit characteristics						Seed characteristics					
		Fruit Size (mm)		Weight of 100 fruits (g)	Number of fruit in 100g	Moisture content (%)	Seed Size (mm)		Weight of 100 seeds (g)	Number of seeds in 100 (g)	Moisture Content (%)	Germination (%)	
		Length	Width				Length	Width					
S1	14-05-18	G	12.80±0.09	13.94±0.03	158.42±0.70	108.33±1.20	79.44±1.53	Im	Im	Im	Im	Im	Im
	21-05-18	G	13.10±0.15	14.11±0.11	179.70±2.30	93.33±1.76	75.47±1.86	Im	Im	Im	Im	Im	Im
	28-05-18	G	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	0.05±0.01	97420.67±4.67	67.67±3.04	1.75±0.10
	04-06-18	G	16.52±0.05	17.92±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	81655.33±1.45	62.29±2.45	26.75±0.53
	11-06-18	YB	17.37±0.11	19.34±0.39	353.08±1.94	36.67±3.33	64.15±2.30	1.63±0.17	1.24±0.08	0.10±0.003	80314.67±3.71	59.58±0.54	48.00±0.57
	18-06-18	YB	19.64±0.29	24.88±0.30	495.08±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	PB	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	G	13.12±0.17	13.65±0.07	164.98±2.01	94.67±0.88	81.17±0.59	Im	Im	Im	Im	Im	Im
	21-05-18	G	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	G	16.70±0.01	18.20±0.04	318.17±3.22	65.33±2.91	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	G	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	YB	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	YB	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	75510.33±0.88	59.20±1.48	76.92±1.90
	25-06-18	PB	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	G	11.46±0.19	11.82±0.16	123.37±0.68	102.33±1.86	82.78±1.63	Im	Im	Im	Im	Im	Im
	21-05-18	G	11.92±0.26	12.50±0.15	132.27±0.64	93.33±3.28	81.08±0.52	Im	Im	Im	Im	Im	Im
	28-05-18	G	16.50±0.21	18.34±0.31	310.53±3.91	70.67±5.36	78.63±1.31	1.21±0.08	1.03±0.03	0.09±0.01	87322.67±1.20	70.84±1.32	16.75±1.92
	04-06-18	G	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±0.01	86704.67±2.60	63.30±1.68	46.75±5.01
	11-06-18	YB	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±0.01	79753.67±1.86	61.94±2.18	56.48±1.84
	18-06-18	YB	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±0.01	75125.33±1.76	55.92±1.81	84.75±2.07
	25-06-18	PB	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±0.01	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 **

Fruit Moisture Content %	Year	81.008	1	81.008	11.232 **
	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 (mm)	Year	4.613	1	4.613
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 (mm)		Year	1.580	1	1.580
	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 Seeds (g)	Year	.001	1	.001
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 Seeds in 100g		Year	1.608	1	1.608
	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 Content %	Year	798.186	1	798.186
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
	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 SIII 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 $12.25\pm 0.102\%$. The germination percentage increases with each collection and was maximum during the last collection. The maximum germination ranged between 48.00 ± 0.06 and $56.02\pm 0.50\%$ (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 $16.75\pm 1.9\%$. In Yr 2 also the maximum germination was during the last collection and was 65.57 ± 2.20 and $85.00\pm 4.60\%$ (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.¹⁵ The poor natural regeneration of most of the *Ficus* species has been reported in many studies though the regeneration of *F. semicordata* is comparatively better than the other species.¹⁶⁻¹¹ 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 esculnta*, *Prunus cerasoides*, *Bauhinia retusa* and *Pyracantha crenulata*.¹⁷⁻¹⁸⁻¹⁹⁻²⁰

Moisture plays a critical role throughout the life of seeds, change in fruit and seed moisture content are strong manifestations that ripeness is progressing.²¹

Decline in moisture content from maturing seeds is closely related to seed maturity.²² In *F. semicordata* also decline in moisture content was a good indicator of maturity. The seed matured when fruit moisture content ranged between $50.25\pm 0.58\%$ and $62.73\pm 2.30\%$ coincided with maximum germination ($48.0\pm 0.06\%$ and $85\pm 4.61\%$). Similar results were also observed in other species of *Ficus* namely *F. lundellii*, *F. microcarpa* and *F. krishnae*.²³⁻²⁴⁻²⁵ *Casuarina equisetifolia* also attain seed maturity when moisture content is below 50%.²⁶

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*.²⁷⁻⁵

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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