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Physiological Maturity Studies of *Myrica Esculenta* in Kumaun Himalaya Uttarakhand

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Abstract

Myrica *esculenta*, Buch-Ham. Ex. D. Don is frequent under-canopy species in the Himalayan woods of Pinus roxburghii and Quercus leucotrichophora. The species is well-known in the Kumaun region for its edible fruit & various by-products, & it has arisen as potential income-generating plant. *M. esculenta* regrowth is poor in natural settings, owing to high anthropogenic pressure. The maturation process aids in determining the best time to harvest when seeds are in better physiological condition for germination. For each collection date in the laboratory, physical characteristics, seed size and weight, and germination were measured in a dual chamber seed germinator. The tree density of M. *esculenta* ranged between 50 and 180 ind ha^{-1}. The mean fruit size between first and last collection varied from 63.43 and 98.73 mm^2 while the weight of 100 seeds between first & final collection varied from 8.55 to 15.67 g across the collection. The highest germination was observed 61.3% when the moisture content of seeds was 32.1%.

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Introduction

Himalaya is one of the youngest and largest mountain systems of the world and is known for its great source of organic and ethnic diversity,[1-2] and the richest biodiversity zone in the terms of qualitative and quantitative from the other part of the world.[3] The Himalaya are sensitive to environmental change, especially climate change and the response of recent warming on plant species are remarkably visible,[4] continuous release of greenhouse gases at the current rates or more would result in more warming up during the 21st century and global temperature would vary between 2.6^{0}C and 4.8^{0}C.[5] Pre maturation of seeds because of warming up of environment and stress may pause this harmonization. Seed and sprouts are the important means of tree regeneration in natural forest. Perennial plants regenerate either through seed or vegetative propagules.

Identification of physical parameters indicating period of maturing just beforehand of dehiscence of the berries is vital to get seeds of extraordinary strength. Gathering of forestry fruits and seeds is significantly assisted by consistent plans of seed development that permits the latest probable assortment.[2,6] Gathering of seeds after dispersal, once they have been exposed to unrestrained environmental situations, can consequence in seeds of poor class.[7] For many plant species the fate of the next generation depends to a certain degree, on the maturation conditions of the seeds when they are still on the mother plant.[8] In several class of species, seed maturing has been linked to physical characteristics.[9-10] Further, with evidence of global warming considerable attention has turned to predict the fate of forests trees.[11]

M. esculenta is a shared under-canopy species of *Q. leucotrichophora* and *P. roxburghii* forests. The species frequently favours humid locations and repeatedly forms distinguishing clusters of its own in the groups. The class of species is broadly dispersed in sub-tropical Himalayas.[12] The fruits of the species are eaten in raw form and different by-products are also consumed in the processed form. *M. esculenta* is also used as fuel wood, fodder for animals and popular medicinal plant used to cure different illness and disorders.[13] The objective of this study is to determine the ascertainment of seed maturation period and relate it with other physical parameters so that its proper seed collection time can be identified for better management.

Material and Methods

The study was conducted at a site located amongst 29º23/N and 79º30/E at an elevation 1720 and 1900 msl elevation. The study sites are situated in Nainital forest division of Kumaun Himalaya. Mean annual temperature of the study site was 14.8^{0}C and total annual precipitation was 2138 mm of which two third occurred during rainy season. In spite of high degree of annual precipitation, season of summer and winter are moderately waterless, usually with < 10cm regular precipitation. In the study 30 quadrats 10x10m were used to finish the phytosociological investigation of sapling class. The size and quantity of the samples were determined following.[14-15] The IVI (importance value index) was ascertained as the total of the relative frequency, density and dominance.[16]

A sample of 20 trees was chosen because they had a perfect stem, a well-established top, and a sufficient number of fruits. Fruit gathering of *M. esculenta* was on-going from the fourth week of April to the accessibility of fruit till the last week of the month of May. The fruit assortment was accomplished in a straight way from the tree before the seed grew in the research laboratory. For fruit and seed corporeal factors three reproduce of 25 fruit/seeds were taken in use and the dissimilar factors comprises of fruit/seed size (mm^2) (length ×width) and weight of 100 fruit/seed. To measure the moisture content of fruit/seed 3 replicates of 75 fruit/seed were in use for all collection days. The moisture content was determined using a fresh mass method in which the fruit/seed was dehydrated for16±1 hour at 103±2°C and then reweighed.[17] Germination experiment was conceded out in a twin chamber seed germinator for every assortment day. Four replicates of 100 seeds each were utilised for germination. For germination 4 replicates of 100 seeds each were used.[18] The process of germination of seeds was conceded out at 25±1ºC on top of paper in seed germinator in a shaded environment. Day-to-day observation was made and germination was calculated after observable protrusion of radical (1mm) arose following Paul.[19]

Results

Tree Layer Analysis

At the research sites the overall tree thickness was diversed between 295 and 855 ind ha^{-1} and entire basal area stretched from 43.76 to 69.14 m^2 ha^{-1}. The tree thickness of *M. esculenta* was 50 to 180 ind ha^{-1}, sapling thickness ranged from 18 to 80 ind ha^{-1} and seedlings thickness was 60 to 140 ind ha^{-1}. Total basal area of *M. esculenta* varied between 13.46 and 15.38 m^2 ha^{-1} and IVI was 48.52 to 66.41.

Fruit Characteristics

The colour of fruit changed from green to dark red amid first and last collection in both the years (Table 1). The average fruit size among 1st and last collection was diversed from 63.43±0.3 to 91.55±0.2 mm^2 in year 1 and 76.5±0.17 to 98.73±0.22 mm^2 in year 2. The average weight of 100 fruits was varied from 28.72±0.15 to 62.1±0.2 g in year 1 and 36.47±0.26 to 63.43±0.3 g in year 2. The mean moisture content of fruits ranged from 60.28±0.38 to 68.78±0.17% in year 1 and 57.27±0.27 to 64.47±0.26% in year 2 between first and last collection (Table 1).

Seed Characteristics

The mean seed size of *M. esculenta* between first and last collection varied from 37.6±0.7 to 58.82±0.2

Table 1. Variation in physical parameters of *M. esculenta* fruits over collection period.

Collection number	Year 1				Year 2		
	Fruit colour	Fruit size (mm^2)	Wt. of 100 fruits (g)	Moisture content %	Fruit size (mm^2)	Wt. of 100 fruits (g)	Moisture content %
I (30 April)	Green	63.43±0.	28.72±0.15	68.78±0.17	76.50±0.	36.47±0.26 17	64.47±0.26
II (5 May)	Green	69.32±0. 42	33.91±0.36	66.60±0.21	83.47±0.	43.60±0.21 15	63.23±0.15
III (14 May)	Red Green	76.02±0. 45	40.48±0.37	65.53±0.27	89.40±0.	54.70±0.38 23	62.73±0.18
IV (21 May)	Red	82.05±0. 43	53.50±0.27	64.49±0.29	93.65±0.	61.50±0.17 16	61.77±0.15
V 28 May	Dark Red	91.55±0. 22	62.10±0.22	60.28±0.38	98.73±0.	63.43±0.29 22	57.27±0.27

Table 2. Variation in physical attributes of *M. esculenta* seed over the collection period

Collection number	Year 1		Year 2	
	Seed size (mm^2)	Wt. of 100 seeds (g)	Seed size (mm^2)	Wt. of 100 seeds (g)
I (30 April)	37.6±0.71	8.6±0.19	46.9±0.17	11.3±0.19
II (5 May)	44.6±0.25	10.7±0.12	54.3±0.23	13.1±0.15
III (14 May)	51.6±0.31	11.3±0.09	56.6±0.26	14.3±0.17
IV (21 May)	54.7±0.27	12.3±0.27	58.6±0.24	14.9±0.10
V 28 May	58.8±0.21	13.9±0.46	60.3±0.26	15.7±0.29

mm^2 in year 1 and 46.9±0.17 to 60.3±0.26 mm^2 in year 2. The average weight of 100 seeds was ranged from 8.55±0.19 to 13.87±0.46 g in year 1 and 11.3±0.2 to 15.67± 0.3 g in year 2 (Table 2).

Germination of Seeds

The mean germination percentage of *M. esculenta* seeds ranged from 7.0±0.06 to 61.3±0.67% in year 1 and 14±0.0 to 35.6±0.0% in year 2. The moisture content percentage ranged between 32.1±0.15 and 48.2±0.7% in year 1 and 28.9±0.5 and 41.7±0.3% in year 2 during the germination (Figure 1). The maximum germination was 61.3±0.6% when the moisture content percent was 32.1±0.15% in year 1 and 58.0±0% when moisture content percent was 32.0±0.30% in year 2.

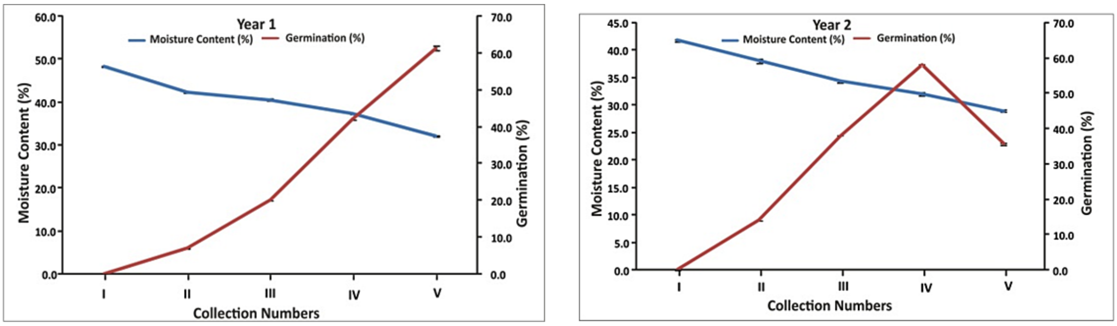

Fig. 1: Effect of moisture content on germination of *M. esculenta* seeds over the collection period

Test statistics of ANOVA test showed that fruits size, heaviness and moistness of 100 fruits were varied pointedly thru the dates of collection and years ($p<0.05$). Interface among year × date was noteworthy for fruit size and weight of 100 fruits ($p<0.05$) but was non-significant for moisture content of fruits. The weight of 100 seeds, seed size, moistness of seeds, and germination varied considerably thru the years and on collection dates ($p<0.05$). The interface among year × date was noteworthy for moistness of seed, germination and seed size ($p<0.05$) but was not noteworthy for weight of 100 seeds.

A significantly positive correlation was found among seed size & weight of 100 seeds, seed size and germination percent, weight of 100 seeds and germination percent ($p<0.01$) and a noteworthy adverse correlation was found among seed size and moistness of seeds, weight of 100 seeds and moistness of seeds & moistness f seeds and germination percent of seeds (Table 3).

Table 3. Pearson correlation between different parameters of seeds of *M. esculenta*

Parameters	Seed size	Weight of 100 seeds	Moisture Content	Germination
Seed size	1	0.944**	-0.962**	0.834**
Weight of 100 seeds		1	-0.967**	0.752**
Moisture content			1	-0.831**
Germination				1

**Correlation is significant at 0.01 level (2-tailed)

Discussion

Present research were more aware of the fact that utmost mature & immature fruits & seeds can be differenced in many ways like by alteration in colours, bigger firmness or brittleness, reduced moistness & precise gravity or by alteration in physical measurements.[10] Physical indices like change in colour have been widely used as a workable sign of development for several species.[20-22] In the present study change in colour from olour green to dark red in *M. esculenta* was establish to be a noble maturity indicator.[23] It was also found dark red or blackish red as one of indicators of maturity in *M. esculenta* which is similar to the present study. Change in colour has constantly been suggested as sign of ripeness, was also observed by[24] for *Shorea robusta*,[21] for *Cornus macrophylla*,[20] for *Quercus leucotrichophora* and[10] for *Betula utilis*. Different colour transformation has continuously been related with fulfilment of maturity; the key motive is that additional indices offer no benefits above these simply experimental indicators[18.]

Besides colour the other physical parameter that is interrelated with maturity is moisture content. Moistness plays a critical role in maturation and alteration in fruit/seed moistness is robust manifestations that ripeness is continuing.[10] Loss of moistness during maturity is a more essential time of seed growth than is obscure by unreceptive notion of seed drying. Decay in moistness in maturing seeds is thoroughly linked to seed maturity.[2,20] In the contemporary research fruit/seed moistness also emerged as a good sign of seed maturity in *M. esculenta*. According to[25] *M. esculenta* attained maturity when seed moisture content ranged between 30.46 and 31.72%.[26] also reported seed moistness between 29.8 and 34.13% as maturity sign in *P. cerasoides*.[23] specified that moistness of 23.4-36.1% can be linked with optimal germination of *Pyracantha crenulata*. The beginning of moistness loss causes a decay in the physical movement of maturity cotyledons as well as embryo before the seed falls[24,27.] In the current state an understanding of how vegetation will respond to climatic irregularities is required for forecasting the reaction of plants to forthcoming weather variation and to develop an understanding for saving the species. If the regeneration of a species is instable at a dissimilar rate from that of the species make up its environmental settings, this will lead to anticipating of its periodic happenings.[28] In Himalaya there are several plantation tree species in which seed maturation is harmonized with the initiation of monsoon, and their seed sustainability is very low.[29]

Conclusion

Present study showed that colour change of fruit from green to dark red and change in physical parameters such as fruits & seeds size, weight & number of fruits and seeds per 100 gm is a reliable indicator of maturity in *M. esculenta*. Besides this fruits and seeds moisture content also appear as useful indicator of maturity. *M. esculenta* seeds attains maturity when the seeds moisture content ranged between 30.46 and 31.72%. The seed moisture content coincided with maximum germination. Thus, the knowledge of seed maturation of this important species can be helpful in promoting this poorly regenerating species.

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Conflict of Interest

The authors do not have any conflict of interest.

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