

# Archaeobotanical Insights into the Plant Economy of Khopadi, District Nagpur, Maharashtra

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## Abstract

This article provides information on the well-flourishing agricultural practices during the Pre-Iron Age and Early Iron Age periods at Khopadi, Taluka Kuhi, District Nagpur, Maharashtra. Crops identified from the site include cereals like rice (*Oryza sativa*) and wild rice (*Oryza* sp.); millets comprise browntop millet (*Brachiaria ramosa*), sawa millet (*Echinochloa* cf. *colona*), little millet (*Panicum sumatrense*), kodo millet (*Paspalum scrobiculatum*), *Setaria* sp., and Italian millet (*Setaria italica*); pulses such as lentil (*Lens culinaris*), horsegram (*Macrotyloma uniflorum*), common pea (*Pisum arvense*), black gram (*Vigna mungo*) and green gram (*Vigna radiata*); and Indian jujube (*Ziziphus* sp.). The remains of wild/weedy taxa comprise the seeds of panicled spot flower (*Acmella paniculata*), white goosefoot (*Chenopodium album*), sedges (*Cyperus* sp., *Fimbristylis* sp.), Indian goosegrass (*Eleusine indica*), wrinkle grass (*Ischaemum rugosum*), panicum grass (*Panicum* sp.), *Pennisetum* sp., pigweed/Santo (*Trianthema portulacastrum*) and wild spinach (*Rumex dentatus*). The archaeobotanical dataset from Khopadi suggests that the site was a part of the agricultural mounded settlement groups.

## Introduction

Significant archaeological work in the Vidarbha region has taken place, including systematic archaeobotanical research. The sites studied include Adam (Kajale 1994, 2016), Tuljapur Garhi (Kajale 1988, 1991), Naikund (Kajale 1981), Bhagimohari (Kajale 1989), Kaundinyapur (Vishnu-Mittre 1968; Naik *et al.* 2014), Rithi Ranjana (Nihildas *et al.* 2018), Malli (Naik and Sontakke 2022), Kholapur (Deotare *et al.* 2012), Bhon (Naik and Deotare 2017), and Mandhal (Kajale 2019). These sites have yielded a significant amount of charred food grains. This paper provides additional data on plant macro-remains from the habitational deposits of the Pre-Iron Age and Early Iron Age periods at Khopadi.

## The Site

Khopadi (22° 37.30' N; 79° 31.30' E) is located 45 km southeast of Nagpur on the right bank of the Nag River and about 2 km east of Kuhi, a tehsil place in Nagpur District (Fig. 1). The Nag River is the right-side tributary of the Wainganga River, which flows on the north side of the site. The site covers an area of 7 to 9 ha and is split by the road into two localities. The surface of the site is undulating due to the cultivated fields, and most of the land has a cultural deposit between 3 and 4 m. The excavations at the site in the 2013-14 and 2015-16 seasons

unearthed a cultural deposit of about 2.5 m thickness. The cultural material revealed four periods of occupation, out of which the lower two of uninterrupted occupation belong to the Pre-Iron Age and Early Iron Age periods. The upper two layers belonging to the Early Historic and Mediaeval periods, are separated by a long hiatus, and show high disturbance due to modern anthropogenic activities (Pawar *et al.* 2014, 2019; Shete and Pawar 2017).

## Material and Methods

The modern vegetation and agricultural practices around the Khopadi site were documented through systematic explorations in order to understand the present flora and cropping patterns of the region. The first author participated in the excavations and systematically collected archaeobotanical remains from the habitation deposits of 'Index Trench A' by means of visual inspection. In addition, three soil samples of approximately 20 kg each were collected from Pre-Iron Age deposits and three from Early Iron Age deposits for wet sieving. These samples were processed by flotation using the bucket-sieving method with a 0.25 mm geological sieve to recover carbonised and silicified plant remains. The retrieved remains were then segregated and categorised under a low-power stereo microscope (Euromex Edu Blue and WILD Heerbrugg M400) at the Deccan College Palaeobotany Laboratory, where photographs of all identified taxa were taken. Most crop seeds/grains, fruit remains, and weedy taxa were well-preserved, though in some cases severe carbonisation obscured diagnostic features. Measurements

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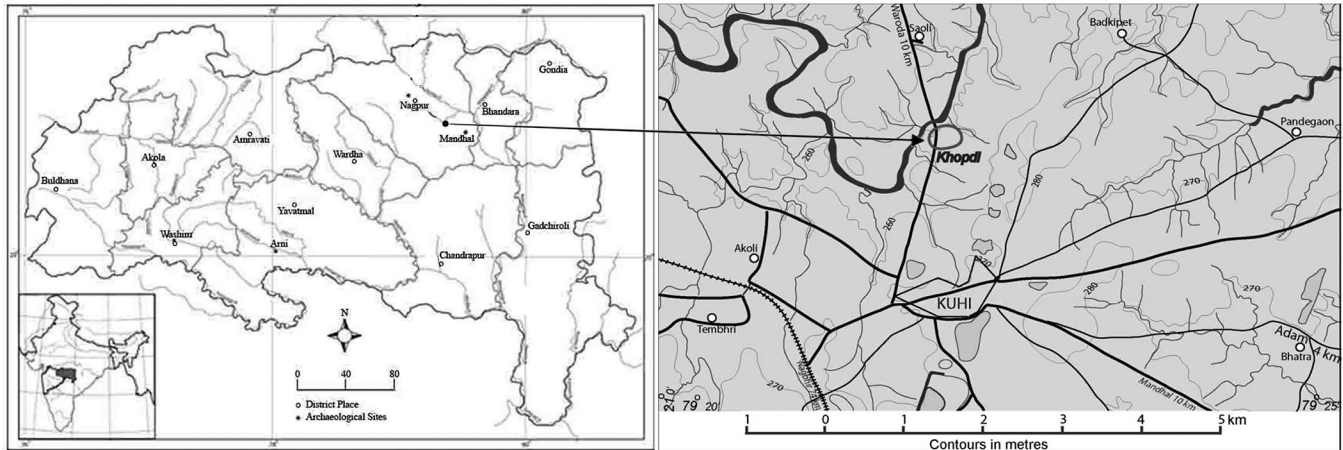


Fig. 1: Location Map of the site

were taken with the software Leica Application Suite X. Identifications were made using the reference collection of the Deccan College Palaeobotany Laboratory, supplemented by standard published works (e.g., Struever 1968; Stewart and Robertson 1973; Robertson 1973; Cappers *et al.* 2009; Pearsall 2009).;

### Modern Vegetation and Agriculture

The vegetation in and around the Khopadi site is relatively scanty and predominantly deciduous, though densely distributed along both banks of the Nag River. It is composed mainly of neem (*Azadirachta indica*), tamarind (*Tamarindus indica*), species of *Ficus*, Indian jujube (*Ziziphus mauritiana*), teak (*Tectona grandis*), flame of the forest/palas (*Butea monosperma*), and bamboo (*Bambusoideae* sp.), along with numerous grasses, herbs, shrubs, and climbers/twiners.

Present-day agricultural practices in the vicinity of Khopadi follow a seasonal cropping pattern. During the summer, farmers primarily cultivate rice (*Oryza sativa*), soybean (*Glycine max*), jowar (*Sorghum vulgare*), cotton (*Gossypium arboreum/hirsutum*), green gram (*Vigna radiata*), and black gram (*Vigna mungo*). In the winter season, wheat (*Triticum aestivum*), maize (*Zea mays*), pulses such as chickpea (*Cicer arietinum*), pigeon pea (*Cajanus cajan*), and cowpea (*Vigna unguiculata*), as well as oilseed crops including mustard (*Brassica juncea*), linseed (*Linum usitatissimum*), and castor (*Ricinus communis*) are cultivated.

Vegetable cultivation, practised on a smaller scale and dependent on water availability, includes cluster bean (*Cyamopsis tetragonoloba*), brinjal (*Solanum melongena*), lady's fingers (*Abelmoschus esculentus*), sweet potato/shakkarkandi (*Ipomoea batatas*), carrot (*Daucus carota* subsp. *sativus*), amaranth/rajgira (*Amaranthus caudatus*), dill/shepu (*Anethum graveolens*), chilli (*Capsicum annuum*

var. *acuminatum*), and onion (*Allium cepa*). In addition to field crops and vegetables, farmers in the vicinity of the Khopadi site also cultivate a variety of horticultural crops. These include citrus orchards with oranges (*Citrus reticulata*) and sweet oranges (*Citrus sinensis*), which are among the region's important commercial fruits, as well as banana plantations (*Musa paradisiaca*) that provide both food and economic value. Custard apple (*Annona squamosa*), a hardy fruit crop well adapted to the semi-arid environment, is also commonly grown, contributing to the diversity of local horticultural practices.

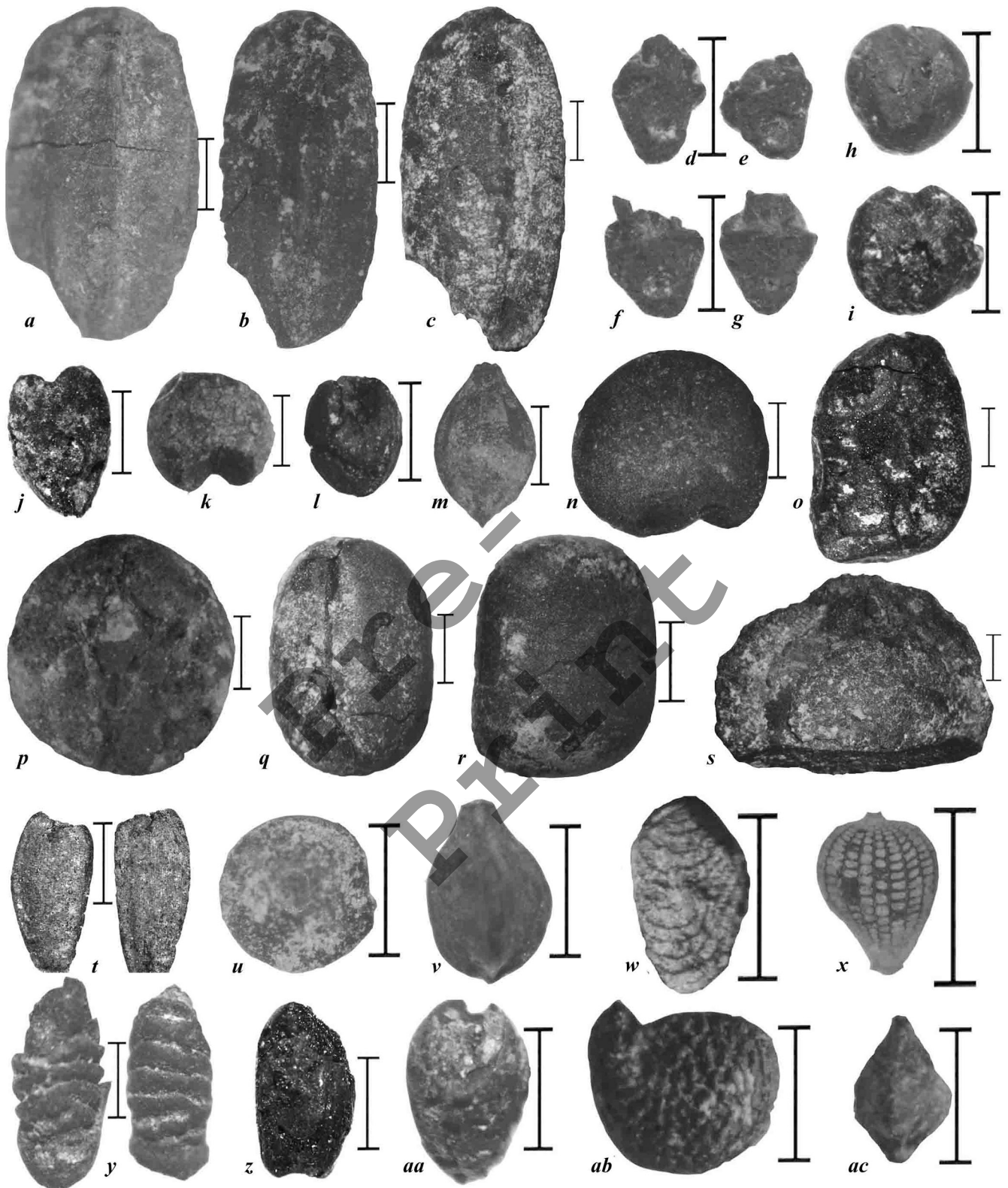
### Results of the Archaeobotanical Studies

The analysis of six archaeobotanical samples, three from the Early Iron Age phase and three from the Pre-Iron Age phase, revealed the presence of cereals, millets, pulses, fruit stones, and several wild/weedy taxa, including paniced spot flower/akarkara, white goosefoot, sedges, Indian goosegrass, wrinkle grass, pigweed/santo, and wild spinach.

#### Cereals

*Oryza sativa* L. (Rice; Fig. 2 a-e)

A substantial quantity of rice grains was recovered from trench A. These remains include whole grains, fragmented grains, detached embryos, grain fragments with embryos, and spikelet bases. The complete grains are elongate to narrowly oblong in shape, laterally flattened, and distinctly ribbed. Husk was observed on a few grains, though not quantified. The grains measure 3.76-5.17 mm in length, 1.60-2.54 mm in breadth, and 1.25-2.13 mm in thickness. In addition, certain potsherds bear impressions displaying the characteristic chessboard pattern of rice husk. Morphologically, the grains are comparable to those of *Oryza sativa* ssp. *indica*.



**Fig. 2:** Archaeobotanical remains from Khopadi. *a-c*, Rice (*Oryza sativa*); *d-e*, Spikelet bases of cultivated rice (*Oryza sativa*); *f-g*, Spikelet bases of wild rice (*Oryza* sp.); *h*, Browntop millet (*Brachiaria ramosa*); *i*, Sawa millet (*Echinochloa* cf. *colona*); *j*, Little millet (*Panicum sumatrense*); *k*, Kodo millet (*Paspalum scrobiculatum*); *l*, *Setaria* sp.; *m*, Italian millet (*Setaria italica*); *n*, Lentil (*Lens culinaris*); *o*, Horsegram (*Macrotyloma uniflorum*); *p*, Common pea (*Pisum arvense*); *q*, Black gram (*Vigna mungo*); *r*, Green gram (*Vigna radiata*); *s*, Fragment of Indian jujube (*Ziziphus* sp.); *t*, Panicked spot flower (*Acmella paniculata*); *u*, White-goosefoot (*Chenopodium album*); *v*, Sedge (*Cyperus* sp.); *w*, Indian goosegrass (*Eleusine indica*); *x*, Sedge (*Fimbristylis* sp.); *y*, Wrinkle grass (*Ischaemum rugosum*); *z*, Panicum grass (*Panicum* sp.); *aa*, *Pennisetum* sp.; *ab*, Pigweed/Santo (*Trianthema portulacastrum*); *ac*, wild spinach (*Rumex dentatus*) (Scale bars = 1 mm).

*Oryza* sp. (wild rice spikelet bases; Fig. 2: f-g)

A single spikelet base from the Early Iron Age level and three from the Pre-Iron Age level were recovered from trench A. The presence of these spikelet bases indicates that wild/ weedy rice species may have been harvested alongsidecultivated rice in ancient times, much as they are today in the region. Their morphological features correspond closely with those of wild rice (*Oryza* sp.).

### Millet

*Brachiaria ramosa* (L.) Stapf. (Browntop millet; Fig. 2h)

Seven grains of browntop millet were recovered from the Early Iron Age phase and twelve from the Pre-Iron Age phase in the archaeobotanical assemblage of trench A. The grains are broadly elliptic with a smooth pericarp; the scutellum is relatively broad with a rounded apex. The hilum is distinctly wide, extending to about one-third to one-half of the caryopsis length. Their dimensions range from 1.14 to 1.39 mm in length and 0.85 to 1.07 mm in breadth, consistent with browntop millet.

*Echinochloa* cf. *colona* (L.) Link. (Sawa millet; Fig. 2i)

Eighteen grains of sawa millet were recovered from the Early Iron Age phase and eight from the Pre-Iron Age phase in the archaeobotanical assemblage of trench A. The grains are ovoid to orbicular in shape, carbonised, with a smooth surface and a distinctly marked hilum scar. Their dimensions range from 0.71-1.35 mm in length, 0.71-1.28 mm in breadth, and 0.49-0.90 mm in thickness. *Echinochloa* cf. *colona*, a species typically growing in waterlogged areas and paddy fields, closely resembles these grains, which are comparable to sawa millet.

*Panicum sumatrense* (Little millet, Fig. 2j)

Eleven grains of little millet were recovered from the Early Iron Age phase and two from the Pre-Iron Age phase of trench A. The grains exhibit a short, shallow scutellum and a pointed apex, a feature uncommon in other millet genera. Their form ranges from elongate-ovate to nearly round. They measure 1.98-2.04 mm in length, 1.28-1.34 mm in breadth, and 1.11-1.15 mm in thickness. These morphological traits correspond closely with those of little millet.

*Paspalum scrobiculatum* L. (Kodo millet; Fig. 2k)

Three grains were recovered from the pre-Iron Age phase of trench A. The grains were separated or dehusked, likely during carbonisation. They are somewhat ovoid in shape with a characteristic plano-convex profile. Their dimensions range from 1.44 to 1.64 mm in length, 1.39 to 1.48 mm in breadth, and 1.16 to 1.26 mm in thickness. These features correspond closely with kodo millet (*Paspalum scrobiculatum*).

*Setaria* sp. (Fig. 2l)

A single dehusked grain of *Setaria* sp. was prominently recovered from the pre-Iron Age phase of trench A. The grain is ovoid to slightly oblong, with a narrow upper end and a curved dorsal side. It measures 1.24 mm in length, 0.80 mm in breadth, and 0.40 mm in thickness. The scutellum is rounded, deep, and thick, appearing straight to concave in longitudinal section; the sides are parallel and nearly semicircular in cross-section. The hilum is broad and conspicuous, extending to about one-third of the caryopsis length. The grain is comparable to those of *Setaria* sp.

*Setaria italica* (L.) P. Beauv. (Italian millet; Fig. 2m)

Four grains of Italian millet were recovered from the Early Iron Age phase and five from the Pre-Iron Age phase in the archaeobotanical assemblage of trench A. They are elliptical plano-convex in nature with slight dorsal dome and tightly fitting lemma and palea on the ventro-lateral sides, measuring 2.18–2.40 mm in length and 1.39–1.60 mm in breadth with a fine ridge on the dorsal surface. The ornamentation and morphological features are similar to those of the millets of *Setaria italica*.

### Pulses

*Lens culinaris* Medik. (Lentil; Fig. 2n)

A single cotyledon was recovered from the Early Iron Age phase, and two complete seeds along with five cotyledons were recovered from the Pre-Iron Age phase of trench A. They are flattened with a keeled margin and are more or less lenticular in shape. The hilum scar is small, acutely lanceolate, and located on the keeled margin. Their dimensions range from 2.02 to 2.52 mm in diameter and 1.00 to 1.23 mm in thickness. These remains are morphologically comparable to *Lens culinaris* (lentil), one of the earliest domesticated legumes of the Old World.

*Macrotyloma uniflorum* (Lam.) Verdc. (Horsegram; Fig. 2o)

A single intact grain of horse gram, ellipsoidal, somewhat kidney-shaped, and laterally flattened with a smooth seed coat, was recovered from the Pre-Iron Age phase of trench A. The specimen measures 4.24 mm in length, 3.09 mm in breadth, and 1.75-1.80 mm in thickness. In both size and morphology, the grain is comparable to modern horse gram (*Macrotyloma uniflorum*).

*Pisum arvense* L. (common pea/field pea; Fig. 2p)

A single complete grain, oval to circular in form, was recovered from the Pre-Iron Age phase of trench A. Owing to carbonisation, the seed coat appears blurred and fractured in places. The grain, identified as a common pea, measures 3.15-3.20 mm in diameter. The hilum scar is small yet distinct. Morphologically, the seed corresponds to modern *Pisum arvense* Linn.

*Vigna mungo* (L.) Hepper (Black gram; Fig. 2q)

A single intact grain, rectangular to sub-cylindrical in form with a smooth surface, was recovered from the Pre-Iron Age phase of trench A. Slightly larger than the grains of green gram, it measures 3.56 mm in length, 2.61 mm in breadth, and 2.59 mm in thickness. The hilum is raised above the seed surface, and the embryo extends up to two-thirds of the cotyledon. These morphological features confirm its identification as black gram (*Vigna mungo*).

*Vigna radiata* (L.) Wilczek (Green gram; Fig. 2r)

Four cotyledons of green gram were recovered from the Early Iron Age phase and seven from the Pre-Iron Age phase in the archaeobotanical assemblage of trench A. They are characterised by somewhat rounded ends, smaller than those of black gram, and appear elongated and slightly cylindrical. The specimens measure 3.10–3.16 mm in length and 2.46–2.51 mm in breadth. These morphological features closely resemble the grains of green gram (*Vigna radiata*).

*Vigna* sp.

Six carbonised fragments of unidentified pulses were recovered from the pre-Iron Age phase of trench A. The fragments are globose in shape, and their morphological traits correspond to those of pulse remains.

#### Fruits and Nuts

*Ziziphus* sp. (Indian jujube; Fig. 2s)

A single fruit-stone fragment was recovered from the Early Iron Age phase and eleven from the Pre-Iron Age phase of trench A. The fragments are globose to sub-oval or spherical, with a rough, convolute endocarp surface. The broken specimens reveal a bicarpellate ovary. The fruit-stones measure 7.46–7.58 mm in diameter.

#### Wild/Weedy Taxa

*Acmella paniculata* (Wall. ex DC.) R.K. Jansen (panicked spot flower/Akarkara; Fig. 2t)

Four seeds of panicked spot flower were recovered from the Early Iron Age phase and three from the Pre-Iron Age phase in the archaeobotanical assemblage of trench A. The seeds are sparsely to densely tuberculate, with distinct cork-like margins, and measure 2.11–2.14 mm in length and 0.94–1.12 mm in breadth. Based on these morphological characteristics, the carbonised specimens have been identified as panicked spot flower (*Acmella paniculata*).

*Chenopodium album* L. (white goosefoot; Fig. 2u)

Nineteen carbonised, complete, shiny seeds, circular to lenticular in form with rounded margins, were recovered from the Early Iron Age phase of trench A. A distinct marginal notch, a key diagnostic feature, is clearly visible. The seeds measure 1.00–1.16 mm in diameter. On

morphological grounds, these carbonised specimens have been identified as white goosefoot (*Chenopodium album*), a common weed in winter crops.

*Cyperus* sp. L. (Sedge; Fig. 2v)

Nine nuts of *Cyperus* sp. were recovered from the Early Iron Age phase of trench A. The nuts are obovate and trigonous, measuring 1.35–1.57 mm in length and 0.87–1.08 mm in breadth, with minute, papillae-like cellular markings on the surface. These plants typically grow in shallow fresh or brackish water, marshy areas, along drains, and in lowland irrigated or tidal rice fields. Based on their morphological characteristics, the specimens have been identified as sedge (*Cyperus* sp.).

*Eleusine indica* (L.) Gaertn. (Indian goosegrass; Fig. 2w)

A single elliptic grain with obliquely striate ornamentation was recovered from the pre-Iron Age phase in the archaeobotanical assemblage of trench A. The grain is elongated, bearing finely striate-punctate ornamentation, and measures approximately 1.34 mm in length and 0.74 mm in breadth. As a common wild grass, it has been identified as Indian goosegrass (*Eleusine indica*).

*Fimbristylis* sp. Vahl. (Sedge; Fig. 2x)

Seven nutlets of *Fimbristylis* sp. were recovered from the Early Iron Age phase and eighteen from the Pre-Iron Age phase of trench A. The nutlets are biconvex, orbicular to ovate, and stalked, measuring about 0.77–1.10 mm in length and 0.57–0.78 mm in breadth. A diagnostic feature is the presence of 7–8 longitudinal grooves intersected by transverse lines, with a rounded to truncate apex. These plants typically occur in wet environments and are commonly noted as weeds in paddy fields. Based on their general morphology, the specimens have been identified as sedge (*Fimbristylis* sp.).

*Ischaemum rugosum* Salisb. (Wrinkle grass; Fig. 2y)

Two intact grains of wrinkle grass were recovered from the Early Iron Age phase of trench A. The grains are oblong with distinct transverse, rugose ridges. In some specimens, glume-I of the sessile spikelets also displays a transversely ridged structure. The grains measure 2.50–2.76 mm in length and 1.05–1.18 mm in breadth, and their morphological traits correspond to those of wrinkle grass (*Ischaemum rugosum*).

*Panicum* sp. L. (Panicum grass; Fig. 2z)

Nineteen carbonised grains of Panicum grass were recovered from the Early Iron Age phase of trench A. The grains are broadly elliptical, measuring 1.90–2.18 mm in length, 1.10–1.22 mm in breadth, and 0.47–0.55 mm in thickness, and in their general morphology closely resemble species of *Panicum*.

*Pennisetum* sp. L. (Fig. 2 aa)

Sixty seeds of *Pennisetum* sp. were recovered from the Early Iron Age phase and two hundred and fifty-three from the Pre-Iron Age phase of trench A. The seeds are elongate, with the embryo occupying nearly half of the seed. Dorsally, they are dome-shaped, while the ventral side is flattened. Their dimensions range from 1.46 to 1.58 mm in length, 1.16 to 1.25 mm in breadth, and 0.44 to 0.51 mm in thickness. Based on these morphological characteristics, the seeds are identified as *Pennisetum* sp.

*Trianthema portulacastrum* L. (Pigweed/Santo; Fig. 2 ab)

A single reniform seed with faint wavy ribs, measuring 1.50 mm in length, 1.25 mm in breadth, and 0.50 mm in thickness, was recovered from the Early Iron Age phase of trench A. It is distinctly beaked near the hilum and closely resembles seeds of *Trianthema portulacastrum*.

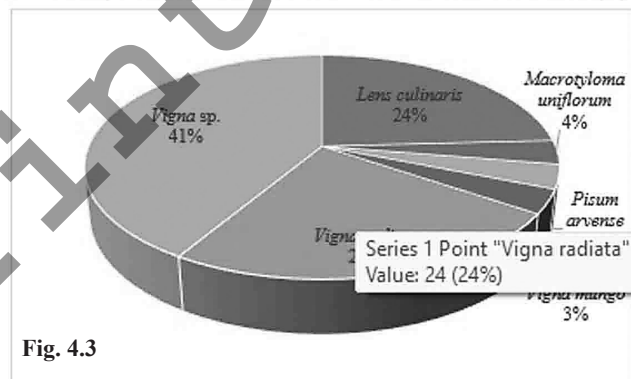
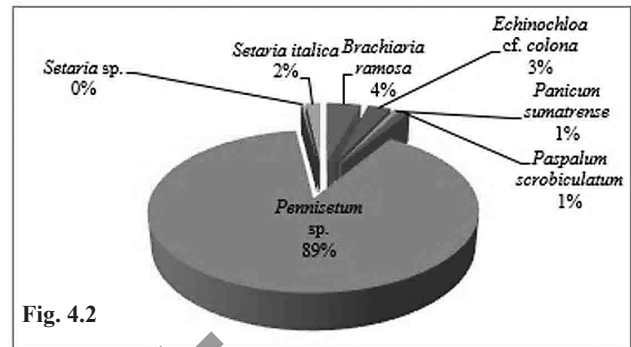
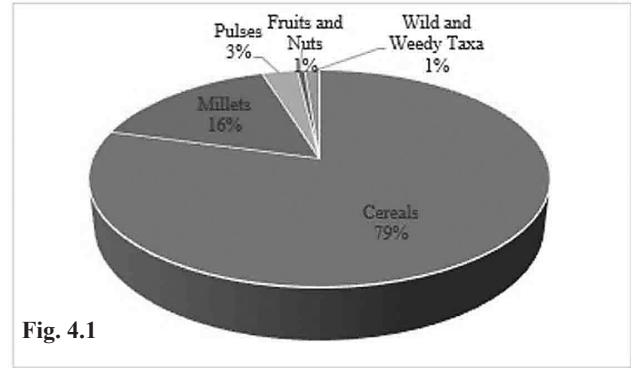
*Rumex dentatus* L. (Jangli palak; Fig. 2 ac)

Five trigonous nuts with pointed apices, smooth surfaces, and sharply defined angles were recovered from the Early Iron Age phase of trench A. They measure 1.50-1.80 mm in length and 1.50 mm in breadth and are comparable to the seeds of *Rumex dentatus*.

**Quantitative Analysis**

A total of six samples from trench A, representing pre-Iron Age/Chalcolithic and Early Iron Age deposits, were analysed for macrobotanical remains. Altogether, 2135 charred plant remains belonging to 28 taxa were identified. These include 1019 grains/seeds of both cultivated and uncultivated plants, 1075 rice grain fragments, 8 unidentifiable millet fragments, and 33 unidentifiable pulse fragments (Table 1).

The quantitative analysis indicates that the plant economy during Chalcolithic/pre-Iron Age phase was dominated by cereals (79%), followed by millets (16%), pulses (3%), and fruits/nuts and wild/weedy taxa (1% each) (Fig. 3.1). The cereals comprise rice (*Oryza sativa*), which overwhelmingly dominates (99.8%), with a negligible proportion of wild rice (0.2%). No other cereals were recovered. Millets are composed of *Pennisetum* sp. (89%), followed by browntop millet (*Brachiaria ramosa*, 4%), sawa millet (*Echinochloa* cf. *colona*, 3%), Italian millet (*Setaria italica*, 2%), and minor occurrences of kodo millet (*Paspalum scrobiculatum*), little millet (*Panicum sumatrense*) (1% each), and *Setaria* sp. (0.1% each) (Fig. 3.2). The pulse assemblage was dominated by *Vigna* sp. (41%), lentil (*Lens culinaris*, 24%), green gram (*Vigna radiata*, 24%), horse gram (*Macrotyloma uniflorum*, 4%), field pea (*Pisum arvense*, 4%) and black gram (*Vigna mungo*, 3%) (Fig. 3.3). Fruits/nuts of *Ziziphus* sp. and unidentified nut remains (1%) may represent collected resources from the surrounding landscape. The wild/weedy taxa (1%) comprise panicled spot flower (*Acmella*



**Fig. 3.1:** Average relative % of abundance of cereals from Pre-Iron Age period. **Fig. 3.2:** Average relative % of abundance of millets from Pre-Iron Age period. **Fig. 3.3:** Average relative % of abundance of pulses from Pre-Iron Age period.

*paniculata*), *Eleusine indica*, and *Fimbristylis* sp., species typically found in rice fields, grasslands, and moist habitats near the site.

The quantitative analysis of the archaeobotanical remains from the Early Iron Age phase shows a well-developed agricultural economy represented by cereals (45%), millets (30%), pulses (4%), fruits/nuts (2%), and a notable increase in wild/weedy taxa (19%) (Fig. 4.1). The cereals comprise rice (*Oryza sativa*), which again dominates (99.4%), with a small proportion of wild rice (0.6%). No other cereals were recorded. Millet assemblage is led by *Pennisetum* sp. (60%), followed

**Table 1:** Absolute counts and ubiquity (%) of plant remains recorded from Pre-Iron Age and Early Iron Age Khopadi

Khopadi 2014 Trench A	Cultural Period	Early Iron Age					Pre-Iron Age				
		Layer No.	3	4	5		6	7	9		
		Depth in m	0.52-0.72	0.72-1.13	1.13-1.50		1.50-1.70	1.70-2.25	2.14-2.35		
Species	Notes				SUM	Ubiquity %				SUM	Ubiquity %
<b>Cereals</b>											
<i>Oryza sativa</i>	Intact grains		3	4	7	66.67	26	19	6	51	100
<i>Oryza sativa</i>	Spikelet bases			6	6	33.33		87	6	93	66.67
<i>Oryza sativa</i>	Embryo ends	4	6	21	31	100	99	159	46	304	100
<i>Oryza sativa</i>	Fragments	19	6	84	109	100	175	569	222	966	100
<i>Oryza sp. Wild</i>	Spikelet bases			1	1	33.33			3	3	33.33
<b>Millet</b>											
<i>Brachiaria ramosa</i>	Intact grains	5		2	7	66.67	12			12	33.33
<i>Echinochloa cf. colona</i>	Intact grains	16		2	18	66.67		7	1	8	66.67
<i>Panicum sumatrense</i>	Intact grains			11	11	33.33			2	2	33.33
<i>Paspalum scrobiculatum</i>	Intact grains							1	2	3	66.67
<i>Setaria sp.</i>	Intact grains								1	1	33.33
<i>Setaria italica</i>	Intact grains	4			4	33.33	3	2		5	66.67
Unidentifiable millet	Fragments	3	5		8	66.67					
<b>Pulses</b>											
<i>Lens culinaris</i>	Intact grains							2		2	33.33
<i>Lens culinaris</i>	Cotyledons			1	1	33.33		3	2	5	66.67
<i>Macrotyloma uniflorum</i>	Cotyledons								1	1	33.33
<i>Pisum arvense</i>	Intact grains							1		1	33.33
<i>Vigna mungo</i>	Intact grains							1		1	33.33
<i>Vigna radiata</i>	Cotyledons			4	4	33.33		7		7	33.33
<i>Vigna sp.</i>	Fragments							6	6	12	66.67
Unidentifiable Pulse	Fragments	9			9	33.33	14	10		24	66.67
<b>Fruits and Nutshells</b>											
<i>Ziziphus sp.</i>	Fragments	1			1	33.33		11		11	33.33
Nut shells	Fragments	2	2		4	66.67					
<b>Wild/Weedy Taxa</b>											
<i>Acmella paniculata</i>	Intact seeds		4		4	33.33		2	1	3	66.67
<i>Chenopodium album</i>	Intact seeds	12	6	1	19	100					
<i>Cyperus sp.</i>	Intact seeds	4	2	3	9	100					
<i>Eleusine indica</i>	Intact seeds								1	1	33.33
<i>Fimbristylis sp.</i>	Intact seeds	7			7	33.33	1	14	3	18	100

Khopadi 2014 Trench A	Cultural Period	Early Iron Age					Pre-Iron Age					
		Layer No.	3	4	5		6	7	9			
		Depth in m	0.52-0.72	0.72-1.13	1.13-1.50		1.50-1.70	1.70-2.25	2.14-2.35			
Species	Notes				SUM	Ubiquity %				SUM	Ubiquity %	
<i>Ischaemum rugosum</i>	Intact seeds	1	1			2	66.67					
<i>Panicum</i> sp.	Intact grains	19				19	33.33					
<i>Pennisetum</i> sp.	Intact grains			60		60	33.33	94	115	45	254	100
<i>Trianthema portulacastrum</i>	Intact seeds		1			1	33.33					
<i>Rumex dentatus</i>	Intact seeds	5				5	33.33					

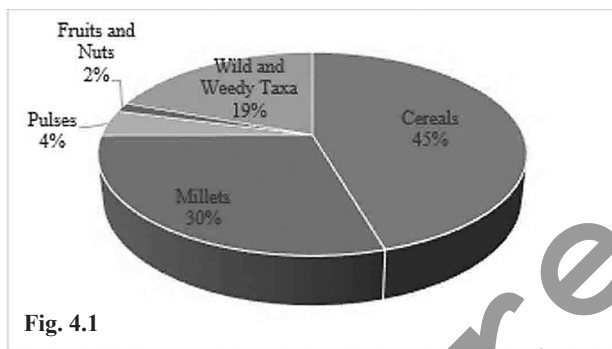


Fig. 4.1

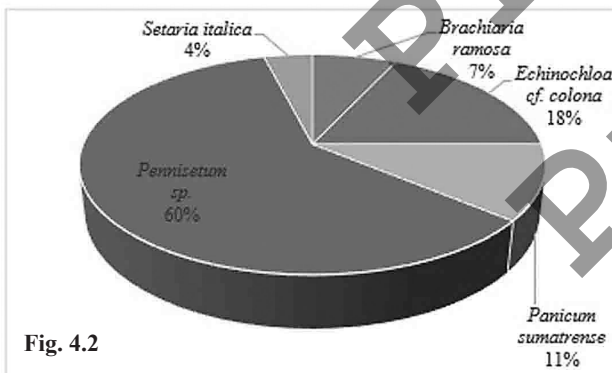


Fig. 4.2

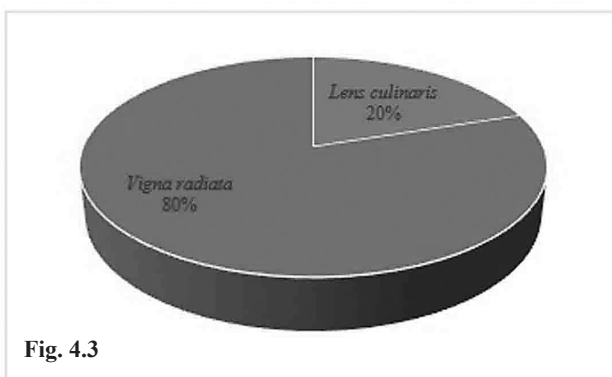


Fig. 4.3

Fig. 4.1: Average relative % of abundance of cereals from Early Iron Age period. Fig. 4.2: Average relative % of abundance of millets from Early Iron Age period. Fig. 4.3: Average Relative % of abundance of pulses from Early Iron Age period.

by sawa millet (*Echinochloa* cf. *colona*, 18%), little millet (*Panicum sumatrense*, 11%), browntop millet (*Brachiaria ramosa*, 7%), and Italian millet (*Setaria italica*, 4%) (Fig. 4.2). Among pulses, green gram (*Vigna radiata*) dominates (80%), with lentil (*Lens culinaris*) comprising the remaining 20% (Fig. 4.3). Fruits/Nuts comprise *Ziziphus* sp. and unidentified nut remains (2%), suggesting collection and consumption from the surrounding environment. Wild/weedy taxa is a group of significant proportion (19%) that includes *Acmella paniculata*, *Chenopodium album*, *Cyperus* sp., *Fimbristylis* sp., *Ischaemum rugosum*, *Panicum* sp., *Trianthema portulacastrum*, and *Rumex dentatus*. These species commonly occur in crop fields, grasslands, and wet habitats near the site.

### Discussion and Conclusions

The archaeobotanical evidence from Khopadi indicates that the occupants practised a self-sufficient arable farming system, with cultivation largely centred on summer crops. Agriculture appears to have been the principal subsistence activity since the Chalcolithic period, as also reflected at neighbouring sites such as Adam (Kajale 1994, 2016) and Tuljapur Garhi (Kajale 1988, 1991), where evidence points to the possibility of crop rotation in the Vidarbha region. The Early Iron Age sites such as Kaundinyapura (Vishnu-Mittre 1968; Naik *et al.* 2014), Naikund (Kajale 1981), Bhagimohari (Kajale 1989), Rithi Ranjana (Nihildas *et al.* 2018), and Malli (Naik and Sontakke 2022) have shown the evidence of an advanced agriculture system prevailing in these parts of Vidarbha.

At Khopadi, rice represents the only cereal crop that occurred in the Pre-Iron Age and Early Iron Age deposits, demonstrating its significance as the primary staple. The prominence of rice cultivation during these phases highlights its role as a major food resource prior to the introduction of crops from other regions into Vidarbha. Given rice's requirement for substantial water availability, its predominance strongly suggests the presence of

favourable hydrological conditions during the occupation of the site. This evidence also contributes to the broader narrative of the spread of cultivated rice across the Indian subcontinent (Naik 2022).

Alongside rice, small-grained indigenous millets were also found, including browntop millet (*Brachiaria ramosa*), sawa millet (*Echinochloa cf. colona*), kodo millet (*Paspalum scrobiculatum*), Italian millet (*Setaria italica*), and foxtail millet (*Setaria* sp. Beauv., cf. *viridis*, *glauca*, *verticillata*). Their presence in both Pre-Iron Age and Early Iron Age deposits suggests that these millets were cultivated together with paddy, probably in wetter environments suited to mixed cropping systems.

Pulses are represented by lentil (*Lens culinaris*), horse gram (*Macrotyloma uniflorum*), common pea (*Pisum arvense*), black gram (*Vigna mungo*), green gram (*Vigna radiata*), additional *Vigna* species, and several unidentifiable pulse fragments. Their recovery in fair numbers points to their cultivation as summer crops, complementing cereal and millet production. Similar assemblages of pulses have been reported from other contemporary sites in Vidarbha (Naik 2022), underscoring their regional dietary importance.

Fruit remains include fragments of Indian jujube (*Ziziphus* sp.), suggesting that the inhabitants may have consumed the raw fruits, with discarded stones subsequently germinating and forming shrubs in and around the settlement. Unidentified nut remains further attest to the exploitation of locally available wild resources.

The assemblage also contains a range of wild/weedy taxa, including *Acmella paniculata*, *Chenopodium album*, *Cyperus* sp., *Fimbristylis* sp., *Ischaemum rugosum*, *Panicum* sp., *Trianthema portulacastrum*, and *Rumex dentatus*. These species typically occur in crop fields, grasslands, and moist habitats such as ditches, ponds, and streams. Their presence provides valuable ecological indicators, helping reconstruct the composition of ground vegetation, the condition of agricultural fields, and the surrounding fallow and grassland landscapes.

The archaeobotanical dataset from Khopadi, dating to the Pre-Iron Age and Early Iron Age periods, demonstrates that rice was the dominant crop cultivated and consumed, with millets, pulses, and fruits playing supplementary roles. The evidence strongly suggests that summer crops such as rice, millets, black gram, green gram, and horse gram formed the core of the agricultural system. The co-occurrence of rice with characteristic wild/weedy taxa associated with paddy fields further confirms fairly wet environmental conditions prevailing in the region during the time of occupation. Overall, the Khopadi assemblage offers a representative picture of seasonal agricultural practices, crop choices, and environmental suitability that shaped subsistence strategies during the Early Iron Age in Vidarbha.

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