~~Effect of sowing time, days to fruit maturity, seed extraction method, seed yield parameters in brinjal var. Anand Raj~~

Effect of Agronomic Factors on Seed Yield and Quality in Brinjal (Solanum melongena L.)

OR

Impact of Sowing Time, Maturity Period, and Seed Extraction Techniques on Seed Yield and Quality in Brinjal (Solanum melongena L.)

Abstract

A ~~The~~ study was ~~on brinjal variety Anand Raj~~ conducted at AAU (Anand Agriculture University), Anand during 2022-24 aimed to standardize sowing time, days to fruit maturity, ~~and~~ seed extraction methods ~~to evaluate the effect of on~~ and seed yield of brinjal variety Anand Raj ~~parameters~~. The research included 48 treatment combinations with three sowing dates (1st week of August, September, and October), four fruit maturity periods in 10 days intervals (60-100 days after fruit formation), and four seed extraction methods (manual, 48-hour fermentation, and acid extraction with HCl and H_2SO_4). The third sowing date (1st week of October) showed the best results in terms of fruit and seed yield parameters, such as highest fruit weight, fruit length, fruit girth, plant height, number of fruits per plant, seeds per fruit, seed yield per fruit, seed yield per plant and 1000-seed weight. Fruits matured at 81-90 days after formation and the manual seed extraction method were found to be most effective for achieving higher seed yield and quality. Thus, sowing in the first week of October with 81-90 days to fruit maturity and using the manual seed extraction method is recommended for optimal seed yield and quality in brinjal variety Anand Raj.

Key words: Brinjal, Date of sowing, Days after fruit formation, Seed extraction methods, Seed yield and crop growth

Introduction

Brinjal (*Solanum melongena* L.), also known as eggplant,. It is a ~~significant~~ vegetable crop in tropical and subtropical regions, particularly in India where it ranks as the second most consumed vegetable after potato. It is extensively grown across various states in India, with major production in Odisha, Bihar, Karnataka, West Bengal, Andhra Pradesh, Maharashtra, and Uttar Pradesh. The plant, native to India, is adaptable and can be cultivated year-round except in high-altitude areas. Brinjal is botanically a herbaceous annual with erect or semi-spreading habits, developing into bushy plants with large, fuzzy leaves. The plant features inflorescences that can be solitary or clustered, with flowers that are large, violet-colored, and hermaphroditic. The fruit, a fleshy berry, varies in shape and color and

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contains seeds embedded in the pulp. The crop is mainly self-pollinated but also benefits from cross-pollination by insects such as bumble bees and honey bees.

Brinjal is highly nutritious, containing significant amounts of carbohydrates, proteins, fats, and various vitamins and minerals. Its medicinal properties make it valuable for treating conditions like diabetes, asthma, and bronchitis. Despite its profitability and demand, brinjal cultivation faces challenges due to the lack of high-quality seeds. Farmers often use low-quality seeds from various agencies, leading to poor germination and yield. Proper harvesting at the right stage of maturity is crucial for maximizing seed viability and vigor. Several methods for seed extraction exist, including wet, dry, and fermentation methods, each with its own advantages and disadvantages. Post-harvest processing, such as seed extraction and drying, is vital for maintaining seed quality. However, there is a need for more research and standardization in these areas to improve seed quality and support the vegetable seed sector effectively.

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Material and Methods

The field experiment was conducted at Main Vegetable Research Station (MVRS), AAU, Anand and laboratory experiment was conducted at the Department of Seed Science and Technology, B. A. College of Agriculture, Anand, Agricultural University, Anand during the period 2022 to 2024. The seeds of Gujarat Round Brinjal 8 (Anand Raj) were obtained from Main Vegetable Research Station (MVRS), Anand Agricultural University, Anand. This study included forty eight treatment combinations involving three date of sowing D_1: 1st week of August; D_2: 1st week of September; D_3: 1st week of October; four days to fruit maturity viz., M_1: 60-70 days after fruit formation; M_2: 71-80 days after fruit formation; M_3: 81-90 days after fruit formation; M_4: 91-100 days after fruit formation and four seed extraction methods viz., E_1: Manual method; E_2: Fermentation method for 48 hour; E_3: Acid extraction method HCl for 30 min; E_4: Acid extraction method H_2SO_4 for 30 min. in the field in three replications with factorial RCBD ~~design~~.

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Seed Extraction Method

Manual method

The mature brinjal fruits were beaten with a stick to separate the pulp, which was then placed in water. The seeds settled at the bottom while the pulp remained suspended and was discarded. The seeds were washed in fresh water and dried in the shade.

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Fermentation method

Fully matured, ripened, yellow brinjal fruits were harvested, washed, and the distal end and seed-free portions removed. The fruits were then crushed, and the seeds were separated from ~~with~~ the pulp, while the fruit wall and debris were discarded. The seed-pulp mixture was fermented in water for 48 hours at room temperature, stirred occasionally to ensure uniform fermentation and prevent seed discoloration. After fermentation, the seeds were separated from the pulp, washed several times with water, and the good seeds were collected while the debris and immature seeds were discarded. The clean seeds were then dried to 8% moisture content and stored in butter paper covers for further testing.

Acid extraction method

In this method, brinjal seeds with pulp were squeezed into plastic containers and mixed with commercial concentrated hydrochloric acid (HCl) and sulfuric acid (H_2SO_4) at concentrations of 5% and 4% respectively, using 50 ml and 40 ml per kg of pulp. The mixture was stirred well and left for 30 minutes. The seeds were then thoroughly washed with a jet of water and repeatedly rinsed using tap water. Finally, the good seeds were drained using a sieve and air-dried under shade or sun.

~~Seed yield~~ Pparameters recorded

Following parameters were recorded during the course of study; ~~The observation on seed growth and yield parameters in field condition viz.,~~ Fruit weight (g), Fruit length (cm), Fruit girth (cm), Plant height (cm), Number of fruits ~~per~~ plant^{-1}, Number of seeds ~~per~~ fruit^{-1}, Seed yield ~~per~~ fruit^{-1} (g), Seed yield ~~per~~ plant^{-1} (g) and 1000 seed weight were measured ~~following standard procedure~~.

Statistical Methods

~~The~~ Collected data ~~observed~~ ~~were~~as statistically analyzed by appropriate statistical methods as worked out using, factorial concept with Randomized Complete Block Design (Gomez and Gomez, 1984) in field condition.

RESULT AND DISCUSSION

Seed yield parameters

Fruit weight (g)

~~The study investigated the effects of sowing time, days to fruit maturity, and seed extraction methods on the fruit weight of brinjal variety Anand Raj over 2022-24.~~ Significant differences were observed between the different dates of sowing, number of days to maturity and seed extraction method for fruit weight (g). However, ~~with~~ the highest fruit weight was recorded during the third sowing date (1st week of October), averaging 773.32 g, and the lowest during the first sowing date (1st week of August) at 500.61 g. Fruit weight peaked at 693.17 g for fruits maturing 81-90 days after formation, with the lowest weight at 604.31 g for 91-100 days maturity. Seed extraction methods did not significantly influence fruit weight,

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though the manual method yielded the highest numerical weight. Similar results were reported with the findings of Shahid et al. (2015) in okra, Singh et al. (2015) in cucumber, Munjal et al. (2019) in brinjal, Daudu et al. (2020) in brinjal, Vinod Kumar et al. (2002) in Paparika, Sureshbabu et al. (2003) in brinjal, Hamsaveni et al. (2003) in tomato, Dhobi et al. (2015) in snake gourd, Kortse et al. (2017) in brinjal, Hayati et al. (2020) in okra, Nisar et al. (2023) in tomato, Padhiyar et al. (2023) in okra, Raghuvanshi et al. (2023) in tomato.

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"Brinjal sown on [date] showed the shortest maturity period of [x days], compared to [y days] for those sown on [date] Table 1."
"The highest fruit weight (g) was observed in seeds extracted using [method], significantly higher than [method 2] ($p < 0.05$)."

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The present study demonstrated that earlier sowing dates significantly reduced the number of days to maturity, with seeds sown on [specific date] maturing [x days earlier] than those sown on [later date]. These findings align with the results of [Author, Year], who reported similar trends in [crop/species]. However, our study observed a more pronounced effect under [specific conditions], potentially due to variations in climatic conditions or soil fertility. Additionally, the seed extraction method significantly influenced germination rates, with [method] yielding the highest germination percentage, consistent with the findings of [Author, Year]. This suggests that [specific mechanism, e.g., reduced seed damage or better preservation of viability] plays a critical role in enhancing seed performance. In contrast, the lower germination observed in [method 2] differs from [Author, Year], which may be attributed to differences in seed handling or storage practices. These results highlight the importance of optimizing sowing dates and extraction techniques for improved productivity in brinjal cultivation.

Fruit length (cm)

The study examined the impact of sowing time, days to fruit maturity, and seed extraction methods on the fruit length of brinjal variety Anand Raj during 2022-24. Significant differences were found, with the third sowing date (1st week of October) achieving the highest fruit length, averaging 26.52 cm, and the first sowing date (1st week of August) the lowest at 21.69 cm. Fruits maturing 81-90 days after formation showed the longest length at 24.83 cm, while those maturing at 91-100 days were shortest at 24.00 cm. Seed extraction methods did not significantly affect fruit length, though the manual method produced the highest numerical lengths. The variations in fruit length were attributed to optimal growing conditions, such as favorable temperatures, adequate sunlight, and balanced moisture levels during the third sowing date and the 81-90 day maturation period. These conditions supported sustained fruit elongation and optimal resource allocation for fruit development. Similar results were reported with the findings of Shahid et al. (2015) in okra, Singh et al. (2015) in cucumber, Sajjan et al. (2005) in okra, Dhobi et al. (2015) in snake gourd, Bortey and Dzomeku (2016) in okra, Hayati et al. (2020) in okra, Nisar et al. (2023) in tomato, Padhiyar et al. (2023) in okra, Raghuvanshi et al. (2023) in tomato.

Fruit girth (cm)

The study investigated the effects of sowing time, days to fruit maturity, and seed extraction methods on the fruit girth of brinjal variety Anand Raj during 2022-24, revealing significant differences. The third sowing date (1st week of October) produced the highest fruit girth, averaging 37.10 cm, while the first sowing date (1st week of August) had the lowest at 33.74 cm. Fruits maturing 81-90 days post-formation showed the greatest girth at 36.10 cm, compared to those maturing in 91-100 days at 35.12 cm. Seed extraction methods did not significantly affect girth, although the manual method resulted in the highest numerical girth. The variations were attributed to favorable growing conditions such as optimal temperatures, adequate sunlight, balanced moisture, and nutrient accumulation during the yellow stage of seed development, leading to increased girth. Comparable outcomes were recorded alongside the discoveries of Shahid et al. (2015) in okra, Singh et al. (2015) in cucumber, Sajjan et al. (2005) in okra,

Bortey and Dzomeku (2016) in okra, Nisar et al. (2023) in tomato, Padhiyar et al. (2023) in okra, Raghuvanshi et al. (2023) in tomato.

Plant height (cm)

The study examined the impact of sowing time, days to fruit maturity, and seed extraction methods on the plant height of the brinjal variety Anand Raj during 2022-24, showing significant differences. The third sowing date (1st week of October) produced the tallest plants, with heights of 93.92 cm and 93.38 cm, while the first sowing date (1st week of August) resulted in the shortest plants, measuring 91.02 cm and 91.03 cm. Plants maturing 81-90 days after fruit formation reached the highest heights at 93.32 cm, compared to 91-100 days at 91.11 cm. Seed extraction methods did not significantly affect plant height, though the manual method yielded the tallest plants. Environmental conditions, such as optimal temperatures, balanced moisture, and higher photosynthetic activity, contributed to the variations in plant height. The findings of were published with comparable outcomes to those of Singh et al. (2015) in cauliflower, Ramadan et al. (2019) in brinjal, Munjal et al. (2019) in brinjal, Daudu et al. (2020) in brinjal, Nikolina (2023) in tomato, Raghuvanshi et al. (2023) in tomato.

Number of fruits per plant

The study on the effect of sowing time, days to fruit maturity, and seed extraction methods on the number of fruits per plant in brinjal revealed significant differences during 2022-24. The third sowing date (1st week of October) yielded the highest number of fruits per plant, with values of 7.71, 7.90, and 7.80, while the first sowing date (1st week of August) had the lowest, at 7.15, 7.25, and 7.20. Fruits maturing 81-90 days after formation showed the highest fruit counts (7.89, 7.94, and 7.92), compared to 91-100 days (7.25, 7.22, and 7.24). Seed extraction methods did not significantly influence fruit count, though manual extraction had numerically higher values. Environmental factors, such as optimal rainfall, temperature, and humidity, likely contributed to these variations. Comparable outcomes were recorded alongside the discoveries of Dilruba et al. (2009) in okra, Latifi et al. (2012) in Cucurbita pepo, Shahid et al. (2015) in okra, Singh et al. (2015) in cucumber, Mohamed et al. (2016) in okra, Begum et al. (2018) in brinjal, Daudu et al. (2020) in brinjal, Hayati et al. (2020) in okra, Nisar et al. (2023) in tomato, Padhiyar et al. (2023) in okra.

Number of seeds per fruit

The study examining the impact of sowing date, days to fruit maturity, and seed extraction methods on the number of seeds per fruit in brinjal revealed significant differences during 2022-24. The third sowing date (1st week of October) consistently produced the highest number of seeds per fruit, with 1241.85,

1278.94, and 1260.40 seeds in 2022-23, 2023-24, and pooled data, respectively, while the first sowing date (1st week of August) resulted in the lowest seed counts. Fruits maturing 81-90 days after formation had significantly more seeds (1104.37, 1106.92, and 1105.64 seeds) than those maturing 91-100 days. Manual seed extraction yielded the highest seed counts, significantly outperforming the acid method (H2SO4 for 30 minutes). Optimal growing conditions, such as favorable weather and efficient nutrient transfer during the third sowing period, contributed to these results, Similar results were reported with the findings of Latifi et al. (2012) in Cucurbita pepo, Rahman et al. (2014) in bitter gourd, Mohamed et al. (2016) in okra, Mends-Cole et al. (2019) in chilli, Daudu et al. (2020) in brinjal, Vinod Kumar et al. (2002) in Paparika, Dhobi et al. (2015) in snake gourd, Kortse et al. (2017) in brinjal.

Seed yield per fruit (g)

The study on the impact of sowing date, days to fruit maturity, and seed extraction methods on seed yield per fruit in brinjal found significant differences during 2022-24. The third sowing date (1st week of October) consistently produced the highest seed yield per fruit (6.61 g, 6.80 g, and 6.71 g), while the first sowing date (1st week of August) resulted in the lowest yields. Fruits maturing 81-90 days after formation had significantly higher seed yields (5.61 g, 5.74 g, and 5.68 g) compared to those maturing 91-100 days. Manual seed extraction yielded the highest seed yields (5.04 g, 5.99 g, and 5.52 g), significantly outperforming the acid method (H2SO4 for 30 minutes). Optimal growing conditions, favorable seasonal factors, and efficient nutrient transfer during the third sowing period contributed to these results, Mohamed et al. (2016) in okra, Mends-Cole et al. (2019) in chilli, Sureshbabu et al. (2003) in brinjal.

Seed yield per plant (g)

The study found that the seed yield per plant in brinjal was significantly affected by the date of sowing, days to fruit maturity, and seed extraction methods across 2022-24. The highest seed yields per plant were consistently recorded with the third sowing date (1st week of October) at 51.28 g, 53.95 g, and 52.62 g, and with fruits maturing 81-90 days after formation at 44.62 g, 46.34 g, and 45.48 g. The manual seed extraction method also yielded the highest results (39.15 g, 46.12 g, and 42.64 g). These results were attributed to optimal growing conditions, favorable seasonal factors, and efficient nutrient transfer, making the third sowing date and manual extraction method the most effective for maximizing seed yield per plant. Comparable outcomes were recorded alongside the discoveries of Singh et al. (2015) in cucumber.

1000 seed weight

The study examined how date of sowing, days to fruit maturity, and seed extraction methods affected the 1000-seed weight in brinjal. The third sowing date (1st week of October) produced the highest 1000-seed weight (5.32 g, 5.29 g, 5.30 g), compared to the first sowing date (1st week of August) with the lowest weights (4.31 g, 4.39 g, 4.35 g). Similarly, seeds matured 81-90 days after fruit formation had the highest weights (4.96 g, 5.08 g, 5.02 g), while those maturing 91-100 days had the lowest (4.50 g, 4.79 g, 4.65 g). The manual extraction method yielded the highest 1000-seed weight (5.00 g, 5.13 g, 5.06 g), whereas the acid method showed the lowest (4.44 g, 4.63 g, 4.53 g). The best results were achieved with the third sowing date, 81-90 days maturity, and manual extraction, highlighting the benefits of optimal growing conditions and efficient extraction methods. Comparable outcomes were recorded along side the discoveries of Shahid et al. (2015) in okra, Gowda et al. (1998) in tomato, Sureshbabu et al. (2003) in brinjal, Hamsaveni et al. (2003) in tomato, Ahmed et al. (2008) in chilli, Takac et al. (2014) in brinjal, Popovic et al. (2022) in brinjal.

Table.1 Effect of date of sowing, days to fruit maturity and seed extraction method on fruit weight (g), fruit length (cm), fruit girth (cm), plant height (cm), number of fruit per plant during 2022-2024 and pooled analysis.

Treatments	Fruit weight (g)			Fruit length (cm)			Fruit girth (cm)			Plant height (cm)			Number of fruit per plant		
	2022-33	2023-24	Pooled	2022-33	2023-24	Pooled	2022-33	2023-24	Pooled	2022-33	2023-24	Pooled	2022-33	2023-24	Pooled
Date of sowing															
D_1	573.78	427.43	500.61	23.46	19.93	21.69	35.75	31.73	33.74	91.02	91.04	91.03	7.15	7.25	7.20
D_2	629.01	676.97	652.99	23.95	26.51	25.23	36.03	36.38	36.20	92.35	92.17	92.26	7.60	7.38	7.49
D_3	814.27	732.37	773.32	26.32	26.73	26.52	37.73	36.48	37.10	93.92	92.83	93.38	7.71	7.90	7.80
S.Em ±	11.99	12.04	8.50	0.21	0.15	0.13	0.29	0.24	0.19	0.72	0.68	0.50	0.11	0.09	0.07
CD at 5 %	33.68	33.80	23.70	0.59	0.43	0.36	0.82	0.67	0.53	2.02	NS	1.38	0.30	0.27	0.20
Days to fruit maturity															
M_1	662.11	602.67	632.39	24.66	24.35	24.50	36.52	34.86	35.69	92.17	91.06	91.61	7.31	7.28	7.29
M_2	663.98	614.72	639.35	24.74	24.45	24.59	36.56	35.08	35.82	92.75	92.94	92.85	7.50	7.58	7.54
M_3	725.27	661.07	693.17	25.04	24.61	24.83	36.80	35.40	36.10	93.58	93.06	93.32	7.89	7.94	7.92
M_4	638.06	570.57	604.31	23.86	24.14	24.00	36.14	34.09	35.12	91.22	91.00	91.11	7.25	7.22	7.24
S.Em ±	13.85	13.90	9.81	0.24	0.18	0.15	0.34	0.28	0.22	0.83	0.79	0.57	0.12	0.11	0.08
CD at 5 %	38.89	39.03	27.37	0.68	NS	0.42	NS	0.78	0.61	NS	NS	1.59	0.34	0.31	0.23
Seed extraction method															
E_1	687.03	631.14	659.09	24.83	24.66	24.75	36.75	35.32	36.04	94.03	92.47	93.25	7.64	7.58	7.61
E_2	674.77	616.26	645.52	24.71	24.42	24.56	36.62	34.85	35.74	92.75	92.31	92.53	7.56	7.53	7.54
E_3	665.23	611.89	638.56	24.39	24.41	24.40	36.37	34.70	35.53	91.97	92.19	92.08	7.53	7.50	7.51
E_4	662.39	589.73	626.06	24.37	24.06	24.21	36.27	34.56	35.42	90.97	91.08	91.03	7.22	7.42	7.32
S.Em ±	13.85	13.90	9.81	0.24	0.18	0.15	0.34	0.28	0.22	0.83	0.79	0.57	0.12	0.11	0.08
CD at 5 %	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

D_1: 1st week of August; D_2: 1st week of September; D_3: 1st week of October; M_1: 60-70 days after fruit formation; M_2: 71-80 days after fruit formation; M_3: 81-90 days after fruit formation;M_4: 91-100 days after fruit formation; E_1: Manual method; E_2: Fermentation method for 48 hour; E_3: Acid extraction method HCl for 30 min; E_4: Acid extraction method H_2SO_4 for 30 min

Table.2 Effect of date of sowing, days to fruit maturity and seed extraction method on number of seeds per fruit, seed yield per fruit (g), seed yield per plant (g), 1000 seed weight during 2022-2024 and pooled analysis.

Treatments	Number of seeds per fruit			Seed yield per fruit (g)			Seed yield per plant (g)			1000 seed weight (g)		
	2022-33	2023-24	Pooled	2022-33	2023-24	Pooled	2022-33	2023-24	Pooled	2022-33	2023-24	Pooled
Date of sowing												
D_1	729.53	726.03	727.78	3.18	3.20	3.19	23.01	23.29	23.15	4.31	4.39	4.35
D_2	799.33	1091.11	945.22	3.68	5.60	4.64	28.11	41.34	34.72	4.57	5.13	4.85
D_3	1241.85	1278.94	1260.40	6.61	6.80	6.71	51.28	53.95	52.62	5.32	5.29	5.30
S.Em ±	18.92	21.24	14.22	0.11	0.12	0.08	0.98	1.05	0.72	0.08	0.07	0.05
CD at 5 %	53.13	59.63	39.67	0.32	0.34	0.23	2.75	2.95	2.00	0.22	0.20	0.15
Days to fruit maturity												
M_1	824.82	1025.77	925.29	3.95	5.06	4.50	28.97	37.24	33.10	4.67	4.85	4.76
M_2	1005.44	1076.21	1040.82	4.89	5.52	5.21	37.03	42.06	39.55	4.80	5.03	4.91
M_3	1104.37	1106.92	1105.64	5.61	5.74	5.68	44.62	46.34	45.48	4.96	5.08	5.02
M_4	759.66	919.22	839.44	3.51	4.49	4.00	25.91	32.46	29.19	4.50	4.79	4.65
S.Em ±	21.85	24.52	16.42	0.13	0.14	0.10	1.13	1.21	0.83	0.09	0.08	0.06
CD at 5 %	61.34	68.85	45.81	0.37	0.40	0.27	3.18	3.40	2.31	0.26	0.24	0.17
Seed extraction method												
E_1	996.40	1151.14	1073.77	5.04	5.99	5.52	39.15	46.12	42.64	5.00	5.13	5.06
E_2	948.02	1049.90	998.96	4.66	5.46	5.06	35.44	41.44	38.44	4.79	5.10	4.95
E_3	916.12	992.11	954.11	4.42	4.93	4.67	33.61	37.26	35.43	4.70	4.88	4.79
E_4	833.76	934.96	884.36	3.85	4.43	4.14	28.33	33.29	30.81	4.44	4.63	4.53
S.Em ±	21.85	24.52	16.42	0.13	0.14	0.10	1.13	1.21	0.83	0.09	0.08	0.06
CD at 5 %	61.34	68.85	45.81	0.37	0.40	0.27	3.18	3.40	2.31	0.26	0.24	0.17

D_1: 1st week of August; D_2: 1st week of September; D_3: 1st week of October; M_1: 60-70 days after fruit formation; M_2: 71-80 days after fruit formation; M_3: 81-90 days after fruit formation;M_4: 91-100 days after fruit formation; E_1: Manual method; E_2: Fermentation method for 48 hour; E_3: Acid extraction method HCl for 30 min; E_4: Acid extraction method H_2SO_4 for 30 min

CONCLUSION

On the basis of field experiments, it can be concluded that the third date of sowing (1st week of October), fruits harvested at 81-90 days after fruit formation and seed extracted by manual method was performed well for seed yield in brinjal variety Anand Raj under Anand condition.

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Plate 1: Bird eye view of date of sowing of experimental site at Main Vegetable Research Station (MVRS), AAU, Anand (*Kharif-rabi* 2022-23)

Plate 2: Field view of experimental site at Main Vegetable Research Station (MVRS), AAU, Anand (*Kharif-rabi* 2023-24)

Manual Method

Fermentation Method

Acid Method: HCl

Acid Method: H_2SO_4

Plate 3: Seed extraction of brinjal var. Anand Raj through various seed extraction methods