Uttar Sona: A medium-slender grain rice variety suitable for cultivation during Boro-season

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Abstract
Uttar Sona has been developed from the cross between MTU 7029 × Gontra Bidhan-1. It was tested under All India Coordinated Rice Improvement Project (AICRIP) in IVT-Boro during 2013-14 and 2014-15. It out yielded national, regional, local and hybrid checks with a yield advantage of 18.57, 29.03, 16.36 and 6.63 per cent, respectively. Overall rank of Uttar Sona during the first year of testing was third in IVT Boro 2013-14 and it ranked sixth during the second year of testing in IVT-Boro 2014-15. The entry has also tested under IVT-E-TP during 2013. It ranked first in IVT-E-TP 2013. Uttar Sona already has been adopted by the farmers of Unishbisha G.P. (Mathabhanga-II block), Patlakhawa G.P. (Cooch Behar-II block), Bamunhat G.P. (Dinhata-II block) and Chotosalbari G.P. (Sitalkuchi block) of Cooch Behar district. It showed field resistance to major pest and diseases.

Key words
Uttar Sona, rice variety, medium slender, Boro-season, West Bengal

INTRODUCTION
Rice is being grown in three seasons, namely Aus (February-March to April-May), Aman (May-June to October-November) and Boro (mid-November to mid-June) in the West Bengal region of India. Area under Aus season is diminishing gradually and only few varieties, namely, Seshaphal, Bittie etc., are available for cultivation. The main season for rice in West Bengal is Aman followed by Boro (irrigated). The percentage shares of these three categories of rice are 4.92, 68.65 and 26.43 with respect to area and 3.84, 62.69 and 33.47 in respect of production, respectively. The average productivity of Aus, Aman and Boro was 2009, 2309 and 3259 kg/ha, respectively and the state average of rice productivity was 2573 kg/ha (Samanta and Mallik, 2004; Anonymous, 2009). Thus, Boro-rice has considerable contribution in the total rice production in West Bengal.

Increasing the yield potential and decreasing the yield-gap of rice crops has been one of the critical challenges to the agricultural research scientists of the state. They have put forth their valuable efforts in enhancing the yield potential of rice in the state to around 5 tons/ha (in term of rough rice). However, rice yield is stagnating over the last decade. To increase the productivity and the total production of rice efforts need to be taken to develop varieties with high productivity (> 5 t/ha), desirable grain type (preferably medium slender), increased nutritional quality (high Fe and Zn content), tolerant to biotic (major insect pests and diseases) and abiotic (particularly, low temperature during Boro-season, drought at reproductive stage during Aman season, and submergence/flood at the vegetative stage during Aman) stresses.

In general, rice breeders, as well as breeders for other crops, tend to cross high-performing parents and select from segregating generations to develop the
new commercial varieties. This strategy is based on the concept that major yield contributing traits in self-pollinated crops are controlled by additive genetic effects. In addition, both high-performing parents present a higher probability of generating superior segregants. To create a rice population for selection, it is important to choose parental materials with high levels of genetic differences for the traits under consideration. Hence, two diverse parents-MTU 7029 and Gontra Bidhan-1 were chosen for crossing to develop a mid-early variety with slender grain and tolerant to most of the biotic and abiotic stresses prevailing in the Tarai Zone and suitable for cultivation during the Boro-season.

**MATERIALS AND METHOD**

A cross was made between MTU 7029 (popular variety, 145 days duration, semi-dwarf rice variety with short bold grain, and high yield potential in low input areas and resistant to BLB) and Gontra Bidhan-1 (it is photoperiod insensitive, medium duration, can be grown in both the Boro and Kharif seasons, semi-dwarf, tolerant to sheath blight, sheath rot and moderately resistant to BPH having high yield potential) during 2009. A promising breeding line designated as Uttar Sona was developed through pedigree selection.

 Initially for two consecutive Boro-seasons, Uttar Sona was tested under at University Research Farm, UBKV, Pundibari as observational trial. On satisfactory performance in the observational trials, the entry was sent for testing under All India Coordinated Rice Improvement Project with four checks, namely Gautam as regional check, IR 64 as national check, Rajalakshmi as hybrid check and Nabin as local check at UBKV, Pundibari). The entry was tested in eight locations in six states (Assam, Bihar, Odisha, Tripura, Uttar Pradesh and West Bengal) during the Boro-season over consecutive two years under AICRP (AICRP Progress Report 2014, 2015). Based on the better performance in two years of trials by AICRP, the entry was further tested under multi-location trial in West Bengal (Table 5). The variety was also tested under adaptive trial in the farmers’ field.

DNA was isolated using standard CTAB method from rice leaves (Xue et al., 2005). Twenty SSRs (Table 3) located across all the 12 chromosomes of rice were selected for DNA fingerprinting. This study was conducted at Mutation Breeding Research Group, NABTD, BARC, Trombay, Mumbai. The SSRs were scored using the actual allele size using QIAxcl Advanced Fully Automated Capillary Electrophoresis system.

### Table 1. Grain yield of Uttar Sona (IET 24171) in IVT-Boro 2013-14 in different states (kg/ha)

| IET No. | Assam | Tripura | West Bengal | Bihar | Odisha | Uttar Pradesh | Mean | Yield advantage over checks (%) |
|---------|-------|---------|-------------|-------|--------|---------------|------|-------------------------------|
| 24170   | 4905  | 4       | 8008        | 6     | 3813   | -             | 3667 | -                            |
| Uttar Sona | 4959  | 3       | 7969        | 7     | 5429   | 1             | 4667 | 5                            |
| 24172   | 4714  | 6       | 6433        | -     | 4526   | 8             | 4917 | 1                            |
| 24173   | 4699  | 7       | 9428        | 1     | 5101   | 2             | 4667 | 5                            |
| 24174   | 3910  | -       | 8031        | 5     | 3700   | -             | 4583 | 6                            |
| 24175   | 4435  | -       | 7119        | 9     | 5051   | 3             | 3500 | -                            |
| 24176   | 4616  | 8       | 7236        | 8     | 3553   | -             | 4167 | 8                            |
| 24177   | 4998  | 3       | 6083        | -     | 4735   | 7             | 4000 | -                            |
| 24178   | 3677  | -       | 3547        | -     | 4859   | 4             | 3417 | -                            |
| 23494   | 5889  | 1       | 8664        | 3     | 4262   | -             | 4250 | 7                            |
| 23499   | 4187  | 6       | 6192        | -     | 4754   | 5             | 4750 | 3                            |
| 23496   | 4471  | -       | 8197        | 4     | 4043   | -             | 4000 | -                            |
| 23498   | 4148  | -       | 2514        | -     | 4278   | 9             | 4000 | -                            |
| Gautam (RC) | 4056  | -       | 2928        | -     | 4750   | 6             | 4750 | 3                            |
| IR 64 (NC) | 4556  | 9       | 6978        | -     | 4227   | -             | 3250 | -                            |
| LC | 4099  | -       | 6883        | -     | 3923   | -             | 3667 | -                            |
| Rajalakshmi | 4794  | 5       | 8781        | 2     | 3639   | -             | 4000 | -                            |
| Ex. Mean | 4536  | 6      | 6764        | -     | 4314   | -             | 4132 | -                            |

NC: National check, RC: Regional check

Source: ICAR-Indian Institute of Rice Research, 2015, Progress Report 2014, Vol. 1, Varietal Improvement, All India Coordinated Rice Improvement Project, ICAR-Indian Institute of Rice Research, Rajendranagar, Hyderabad 500 003, Telangana State, India, p. 1.343.

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RESULTS AND DISCUSSION

Uttar Sona out yielded national, regional, local and hybrid checks with a yield advantage of 18.57, 29.03, 16.36 and 6.63 per cent, respectively and it ranked first in West Bengal based on grain yield (kg/ha) in IVT Boro 2013-14 (Table 1). Across other states it ranked third. It was significantly superior to regional and local checks at Karimganj (4th, 5194 kg/ha), Varanasi (9th, 7533 kg/ha) and Pundibari (1st, 5333 kg/ha). It was also significantly superior to national and local checks at Chinsurah (3rd, 5524 kg/ha). Uttar Sona was superior to regional check at Arundhatiinaga (7th, 7969 kg/ha) national check at Pusa (5th, 4667 kg/ha) and CRRI (7th, 5139 kg/ha). State wise it ranked first in West Bengal (5429 kg/ha), 3rd in Assam (4959 kg/ha) and 7th in Tripura (7969 kg/ha) with 8.83, 14.20 and 14.28 per cent yield advantage over the respective best check. It also out yielded the hybrid check by 49.18 per cent in West Bengal.

The performance of Uttar Sona during Boro 2014-15 (ICAR-IIRR, 2016) is given in Table 2. In respect of mean grain yield, it ranked third in West Bengal and stood sixth based on overall mean (5017 kg/ha). It ranked first in Tripura (6035 kg/ha) and 4th in Bihar (4255 kg/ha). However Uttar Sona was not promoted for the third year of testing due to its lower value of overall mean yield.

As per the ICAR-IIRR report (ICAR-IIRR, 2014), Uttar Sona was significantly superior to all the three checks (Table 3) during Kharif-2013 in IVT-E-TP trial at Kaul (5600 kg/ha, 5th), Varanasi (7650 kg/ha, 2nd), Sakoli (3768 kg/ha), Warangal (9013 kg/ha, 1st), Aduthurai (4575 kg/ha, 8th) and Kurumbapet (6500 kg/ha). Against regional and local check it showed a superior yield at Ludhiana (6012 kg/ha, 6th). This entry performed well over the best check at Punjab (6th, 18.84%), Haryana (5th, 31.76%), Uttar Pradesh (1st, 37.84%), West Bengal (1st, 13.28%), Bihar (9th, 10.37%), Madhya Pradesh (10.14 %), Maharashtra (7th, 7.03%), Gujarat (5.87%), Andhra Pradesh (30.15%), Tamil Nadu (7.19%), Kerala (6.20%) and Puducherry (10.64%). In the region 4 and 5 it out yielded best checks with a yield advantage of 6.96 and 12.19 per cent, respectively. Uttar Sona ranked first during Kharif 2013 based on overall average yield (5364 kg/ha) under IVT-E-TP. It out yielded national, regional and local checks viz., 8.60, 47.96 and 14.36 per cent, respectively, on over all mean basis. Based on the overall performance in IVT-E-TP trial, it was promoted to AVT-1-E-TP, however due unavailability of seeds during the next Kharif season, the trial was not continued.

Multi-locational trials were conducted at RRS-Chinsurah (RRI, 2018), RRS-Pundibari and RRS-Majhian during Boro 2016-17. Uttar Sona performed well as compared to local checks in all the location under multi-location trials in West Bengal (Table 4). Yield increase over local checks Khitish and Nabinby 13.42 and 14.62 per cent, respectively.

Table 2. Grain yield of Uttar Sona (IET 24171) in IVT-Boro 2014-15 in different states (kg/ha)

| IET No.  | Assam | Bihar | Odisha | Tripura | Uttar Pradesh | West Bengal | Mean | Yield advantage over checks (%) |
|----------|-------|-------|--------|---------|---------------|-------------|------|-----------------|
|          | Yield Rank | Yield Rank | Yield Rank | Yield Rank | Yield Rank | Yield Rank | Yield Rank |                  |
| 24173    | 4684 3 | 3056 7 | 3528 5 | 4891 1 | 8000 1 | 9300 1 | 5353 3 | 2                |
| Uttar Sona | 4093 6 | 3611 4 | 3858 8 | 6035 1 | 5223 1 | 9130 3 | 5017 6 | 1                |
| Gautam (RC) | 2566 - | 3889 3 | 4378 5 | 5524 7 | 5807 4 | 8395 4 | 4461 8 | 12.46           |
| 24172    | 3818 7 | 3472 5 | 4909 4 | 5280 8 | 6700 6 | 9295 2 | 5139 5 | 1                |
| 24177    | 3181 - | 1667 1 | 2441 2 | 4550 5 | 5267 5 | 3895 3 | 3420 - | 1                |
| 24394    | 4797 2 | 5417 2 | 6436 2 | 5597 5 | 7600 3 | 5895 7 | 5667 - | 1                |
| IR 64 (NC) | 3421 8 | 2361 2 | 3505 4 | 5645 4 | 4600 6 | 6430 8 | 4100 2 | 22.36           |
| 24897    | 3213 - | 3889 3 | 3533 3 | 4453 - | 6033 8 | 6165 - | 4214 - | 1                |
| 24898    | 5037 1 | 5694 1 | 4618 6 | 5572 6 | 7667 2 | 6595 7 | 5657 2 | 2                |
| LC       | 4373 4 | 3056 7 | 5391 3 | 5986 3 | 7267 4 | 5300 5 | 5015 7 | 1                |
| 24899    | 3376 - | 1250 1 | 4668 5 | 4891 1 | 6833 5 | 6995 5 | 4346 - | 1                |
| Rajalakshmi | 4144 5 | 3889 3 | 6653 1 | 6010 2 | 6600 7 | 6800 6 | 5298 4 | 05.30           |
| 24900    | 3642 - | 3194 6 | 2997 4 | 4502 1 | 4633 5 | 5000 5 | 3906 - | 1                |
| Ex. Mean | 3873 - | 3419 4 | 4378 - | 5303 - | 6325 - | 6861 - | 4738 - | 1                |

NC: National check, RC: Regional check

Source: ICAR-Indian Institute of Rice Research, 2016, Progress Report 2015, Vol. 1, Varietal Improvement, All India Coordinated Rice Improvement Project, ICAR-Indian Institute of Rice Research, Rajendranagar, Hyderabad 500 003, Telangana State, India, p. 1.180.

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Table 3. Grain yield of Uttar Sona in IVT-E-TP during Kharif, 2013

| Regions     | States          | Locations          | Uttar Sona Yield (kg/ha) | Rank | National Check Yield (kg/ha) | Rank | Regional Check Yield (kg/ha) | Rank |
|-------------|-----------------|--------------------|--------------------------|------|------------------------------|------|-----------------------------|------|
| Region-II   | Uttarakhand     | Pantnagar          | 1668                     | -    | 3590                         | #$   | 2352                        | -    |
|             | Punjab          | Ludhiana           | 6012                     | 6    | 5059                         | $    | 4367                        | -    |
|             | Haryana         | Kaul               | 5600                     | 5    | 4250                         | $    | 3850                        | -    |
|             | Mean of Region-II | -                | 4427                     | #$   | 4300                         | #$   | 3523                        | -    |
| Region-III  | Odisha          | CRRI, Cuttack      | 3400                     | -    | 4315                         | 8    | 3685                        | -    |
|             | Mean            |                    | 4048                     | -    | 5264                         | 1    | 2812                        | -    |
|             | Bihar           | Patna              | 5571                     | 9    | 5048                         | $    | 2381                        | -    |
|             | West Bengal     | Chinchurah         | 5923                     | 1    | 5229                         | -    | 4412                        | -    |
|             | Uttar Pradesh   | Varanashi          | 7650                     | 1    | 5550                         | $    | 5250                        | -    |
|             | Madhya Pradesh  | Waraseoni          | 3395                     |    | 2573                         | #    | 1325                        | -    |
|             | Mean            |                    | 3524                     | #    | 3200                         | #    | 1628                        | -    |
|             | Mean of Region-III | -               | 4898                     | 2    | 4679                         | 6    | 2989                        | -    |
| Region-IV   | Maharashtra     | Karjat             | 5811                     | 4    | 5192                         | -    | 5636                        | -    |
|             |                  | Sakoli             | 3768                     | *#$ | 3110                         | #    | 2153                        | -    |
|             |                  | Vadagon            | 4874                     | -    | 5202                         | 6    | 4722                        | -    |
|             |                  | Mean               | 4818                     | 7    | 4501                         | #    | 4170                        | -    |
|             | Gujarat         | Vyra               | 5165                     | #    | 4664                         | #    | 2655                        | -    |
|             |                  | Dabholi            | 4216                     | #    | 4118                         | #    | 2745                        | -    |
|             | Mean            |                    | 4690                     | #    | 4391                         | #    | 2700                        | -    |
|             | Mean of Region-IV | -                | 4767                     | #$   | 4457                         | #    | 3582                        | -    |
| Region-V    | Andhra Pradesh  | Marutheuru         | 3699                     | 7    | 3742                         | 5    | 1205                        | -    |
|             |                  | Warangle           | 9013                     | 1    | 6025                         | 4    | 4391                        | -    |
|             |                  | Mean               | 6356                     | 1    | 4833                         | 4    | 2798                        | -    |
|             | Tamil Nadu       | Coimbatore         | 8529                     | 1    | 7813                         | -    | 6622                        | -    |
|             |                  | Ambasamudram       | 5875                     | -    | 6625                         | #    | 5688                        | -    |
|             |                  | Adudurai           | 4575                     | 8    | 3268                         | #    | 1471                        | -    |
|             |                  | Mean               | 6326                     | 6    | 5902                         | #    | 4593                        | -    |
|             | Kerala           | Moncompu           | 2989                     | #    | 1618                         | -    | 1592                        | -    |
|             |                  | Pattambi           | 4942                     | #    | 4365                         | -    | 3968                        | -    |
|             | Mean            |                    | 4942                     | #    | 4365                         | #    | 3968                        | -    |
|             | Karnataka        | Mandya             | 7276                     | 8    | 6793                         | -    | 5672                        | -    |
|             |                  | Brahmapavr        | 4175                     | 2    | 3687                         | 4    | 2925                        | -    |
|             |                  | Gangavati          | 8102                     | #    | 7716                         | #    | 4784                        | -    |
|             |                  | Mean               | 6518                     | 8    | 6065                         | #    | 4461                        | -    |
|             | PY               | KYP                | 6500                     | *#$ | 5500                         | #    | 4500                        | -    |
|             | Mean of Region-V | -                 | 6269                     | 1    | 5553                         | #    | 4123                        | -    |
|             | Overall Mean     |                    | 5364                     | 1    | 4939                         | #    | 3625                        | -    |

*: Superior to NC; #: Superior to RC; $: Superior to LC

Source:
Directorate of Rice Research, 2014, Progress Report, 2013. Vol.I, Varietal Improvement All India Coordinated Rice Improvement Programme (ICAR) Directorate of Rice Research, Rajendranagar, Hyderabad – 500 030, AP, India. p. viii. & p. 1.96.

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Table 4. Performance of the proposed entry Uttar Sona in respect of its grain yield under multilocation trials in West Bengal during Boro 2016-17

| S.No. | Breeding lines | Locations                  | Mean yield (t/ha) | Yield increase over check (%) |
|-------|----------------|----------------------------|------------------|-------------------------------|
|       |                | RRS, Chinchurah Yield (t/ha) | RRS, Pundibari Yield (t/ha) | RRS, Majhian Yield (t/ha)     |
| 1.    | Uttar Sona     | 5.10                        | 5.38             | 5.76                          | 5.41                          |
| 2.    | Local Check    |                             |                  |                               |                               |
| i.    | Khitish        | 4.30                        |                  | 5.23                          | 4.77                          | 13.42                         |
| ii.   | Nabin          | -                           | 4.72             | -                             | 4.72                          | 14.62                         |

Sources:
Technical Programme of Rice- Boro 2016-17, Rice Research Station, Chinchurah, Hoogly
Annual Report on Rice Research, 2016-17, UBKV, Pundibari, Cooch Behar 736165, West Bengal, UBKV, Pundibari, Cooch Behar

Table 5. Yield of Uttar Sona at farmers’ field during Boro and Kharif seasons (kg/ha)

| Seasons       | Designation  | F1    | F2    | F3    | F4    | Mean  | % increase over check |
|---------------|--------------|-------|-------|-------|-------|-------|------------------------|
| Boro 2014-15  | Uttar Sona   | 7483  | 8350  | 6331  | 7225  | 7347.25 | 66.24                  |
| MTU 1010      |              | 4537  | 4701  | 4328  | 4113  | 4419.75 | -                      |
| Boro 2015-16  | UBKVR-1      | 7530  | 7386  | 7490  | 7050  | 7364.00 | 63.58                  |
| MTU 1010      |              | 4627  | 4510  | 4308  | 4562  | 4501.75 | -                      |
| Kharif 2015   | UBKVR-1      | 6530  | 6601  | 6475  | 7015  | 6655.25 | 63.58                  |
| MTU 1010      |              | 4100  | 3660  | 3975  | 4088  | 3955.75 | -                      |
| Kharif 2016   | UBKVR-1      | 6425  | 6600  | 6533  | 6820  | 6594.50 | 80.29                  |
| MTU 1010      |              | 3865  | 3590  | 3766  | 3410  | 3657.75 | -                      |

F1: Shri Bharat Barman, Village- Khankabari, Unishibisha G.P., Ghoskadanga, Mathabunga-II, Cooch Behar dist.; F2: Manick Barman, Jayantir Hat, Mathabunga-II, Cooch Behar dist.; F3: Shri Benzamin Oraon, Village- Singhimari (Tribalpara), Patlakhawa G.P., Cooch Behar-II, Cooch Behar dist.; F4: Shri Ramkrishna Barman, Village- Petlanepra, Chhoto Salbari G.P., Sitalkuchi, Cooch Behar dist.

The yield performance in large scale demonstrations in farmers’ fields were given in Table 5. The trials were conducted at four farmers’ field during Kharif 2014 and 2015 as well as during Boro 2014-15 and 2015-16. Uttar Sona showed more than 60 per cent yield advantage over local check for all the test seasons in Boro and Kharif.

The results (Table 6) revealed that the Uttar Sona recorded the highest grain yield of 6.90 t/ha under 160 : 80 : 80 kg/ha of NPK and it was statistically at par with 120 : 60 : 60 kg/ha of NPK (6.80 t/ha). Hence, the nutrient dose of 120 : 60 : 60 kg/ha of NPK may be recommended for Uttar Sona for achieving higher productivity during the Boro season in West Bengal. Similar fertilizer dose (130 : 65 : 65 kg/ha of NPK) also has been recommended by Adhikari et al. (2011) for Boro rice.

The result showed that the proposed entry, IET 24171 was found to have a very low incidence of stem borer (0.09-0.10%) indicating its reaction in-between highly resistant to resistant. The said entry did not show any incidence of brown plant hopper, white back plant hopper, gal midge, leaf folder and white maggot during Boro 2013-14 and 2014-15. But it showed a very low incidence of leaf folder (0.37% Damaged Leaf) during Boro 2016-17.

Uttar Sona attained 50% flowering during Kharif-season at 90th day after sowing. However it attained 50% flowering during Boro-season at 133rd day after sowing (Table 7). As per the guideline of PPV & FRA, Uttar Sona categorized as medium duration rice (PPV & FRA, 2007). The average plant height of Uttar Sona was 105.0 cm and it fall under short (91-110 cm) category (PPV & FRA, 207). It showed an average of 304 panicles/m² with a test weight of 21.15 g.
Table 6. Performance of Uttar Sona grown under different levels of NPK during Boro, 2016-17

| Genotypes/ Fertilizer dose | T1 | T2 | T3 | T4 | T5 | Mean |
|----------------------------|----|----|----|----|----|------|
| UBKVR-15                   | 7.20 | 7.20 | 6.00 | 5.50 | 3.40 | **5.86** |
| UBKVR-15A                  | 3.60 | 5.10 | 4.60 | 3.40 | 2.20 | **3.78** |
| UBKVR-36                   | 6.00 | 6.30 | 5.50 | 4.00 | 3.10 | **4.98** |
| UBKVR-46                   | 6.10 | 6.20 | 4.60 | 4.00 | 3.00 | **4.78** |
| Uttar Sona                 | 6.90 | 6.80 | 5.00 | 4.20 | 4.00 | 5.38 |
| Nobin                      | 6.60 | 6.38 | 4.50 | 3.30 | 2.80 | **4.72** |
| Mean                       | 6.07 | 6.33 | 5.03 | 4.07 | 3.08 | **4.72** |

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C.D. (5%) 0.6025 0.2460 0.2695

Source: Annual Report on Rice Research, 2016-17, UBKV, Pundibari, Cooch Behar 736165, West Bengal

Table 7. Yield attributing and grain quality characters of Uttar Sona in different trials

| Characters | IVT-E-TP 2013 | IVT-Boro 2013-14 | IVT-Boro 2014-15 | Tested at BARC | Mean |
|------------|---------------|------------------|------------------|----------------|------|
| Days to 50% flowering | 90.00 | 133.00 | 134.00 | - | - |
| Plant height (cm) | 112.00 | 100.00 | 103.05 | - | 105.00 |
| Number of panicles per m² | 328.00 | 305.00 | 303.00 | - | 304.00 |
| Hulling (%) | - | - | 75.00 | - | 75.00 |
| Milling (%) | - | - | 66.90 | - | 66.90 |
| Head rice recovery (%) | - | - | 53.20 | 61.80 | 57.50 |
| Kernel length (mm) | - | - | 5.47 | - | 5.47 |
| Kernel breadth (mm) | - | - | 2.05 | - | 2.05 |
| L/B ratio | - | - | 2.66 | - | 2.66 |
| Grain type | - | - | - | - | Medium slender |
| Grain chalk | - | - | Very occasionally present | - | Very occasionally present |
| Alkali spreading value | - | - | 4.00 | - | 4.00 |
| Amylose content (%) | - | - | - | 21.02 | 21.02 |
| Gel consistency | - | - | 53.00 | - | 53.00 |
| Test weight (g) | - | - | - | - | 21.15 |

Sources:
1. ICAR-Indian Institute of Rice Research, 2015, Progress Report 2014, Vol. 1, Varietal Improvement, All India Coordinated Rice Improvement Project, ICAR-Indian Institute of Rice Research, Rajendranagar, Hyderabad 500 003, Telangana State, India, p. 1.341-1.344.
2. ICAR-Indian Institute of Rice Research, 2016, Progress Report 2015, Vol. 1, Varietal Improvement, All India Coordinated Rice Improvement Project, ICAR-Indian Institute of Rice Research, Rajendranagar, Hyderabad 500 003, Telangana State, India, p. 1.182.
3. Directorate of Rice Research, 2014, Progress Report, 2013, Vol.1, Varietal Improvement All India Coordinated Rice Improvement Programme (ICAR) Directorate of Rice Research, Rajendranagar, Hyderabad – 500 030, AP, India. p. viii. & pp. 1.95, 1.119, 1.122, 1.125.
Fig. 1. Pictorial depiction of different features of Uttar Sona (IET 24171). A) Standing crop at famers’ field (Shri Bharat Barman, Kharikabari, Unishbisha G.P., Mathabhanga-II, Cooch Behar district); B) Farmers’ participatory varietal selection at Patlakhawa G.P. (Cooch Behar-II, Cooch Behar district, West Bengal)- farmers selected Uttar Sona along with other four varieties as best performing varieties; C) Un-dehusked rice of Uttar Sona; D) Dehusked rice of Uttar Sona; E) Length of un-dehusked rice Uttar Sona; F) Length of dehusked rice of Uttar Sona [length: 5.47 cm, breadth: 2.05 mm, L:B ratio- 2.66, gain type- medium slender].
Grains of Uttar Sona are medium slender (Table 7; Fig. 1). It bears excellent cooking qualities. Other quality characters hulling (%), milling (%) and head rice recovery were 75.00, 66.90 and 57.50 per cent, respectively. Amylose content was 24.64 per cent with medium gel consistency (53.00) indicating separable and soft cooked rice as preferred in India. Amylose content is an important rice grain quality parameter in respect of consumer preference. In India, consumers prefer medium (20-25%) amylose content in the endosperm and this is an important parameter for promotion of rice entries during All India Rice Improvement Project (Anonymous, 2017). Starch content (amylose) of rice is very important factors in grain yield, processing and palatability.

Coleoptile of Uttar Sona is colourless (Table 8). It bears white coloured split type of ligule. It shows medium tillering ability. Stem length of this variety is very short (excluding panicle length). It has semi-erect culm and droopy panicle, bright straw coloured lemma and palea and well exerted panicle. Other morphological and qualitative characters of Uttar Sona based on the “Guidelines for the Conduct of Test for Distinctiveness, Uniformity and Stability on Rice (OryzasativaL.)” of PPV&FRA (2007) are given in Table 8.

Among 20 SSR markers, all markers were found to be highly polymorphic (Table 9, Fig. 2). Twelve markers had unique alleles present which can be used to distinguish

Table 8. Morphological and qualitative characters of Uttar Sona based on the PPV&FRA (2007)

| S. No. | Characters                               | Classification          |
|-------|-----------------------------------------|-------------------------|
| 1.    | Coleoptiles: Colour                     | Colourless              |
| 2.    | Basal leaf: sheath colour               | Green                   |
| 3.    | Leaf: Intensity of green colour         | Dark                    |
| 4.    | Leaf: Anthocyanin colouration           | Absent                  |
| 5.    | Leaf sheath: anthocyanin colouration    | Absent                  |
| 6.    | Leaf: Pubescence of blade surface       | Medium                  |
| 7.    | Leaf: Auricle                           | Present                 |
| 8.    | Leaf: Anthocyanin colouration of auricle| Colourless              |
| 9.    | Leaf: Collar                            | Present                 |
| 10.   | Leaf: Anthocyanin colouration of collar | Absent                  |
| 11.   | Leaf: Ligule                            | Present                 |
| 12.   | Leaf: Shape of ligule                   | Split                   |
| 13.   | Leaf: Colour of ligule                  | White                   |
| 14.   | Leaf: Length of blade                   | Medium                  |
| 15.   | Leaf: Width of blade                    | Medium                  |
| 16.   | Culm: attitude                          | Semi-erect              |
| 17.   | Flag leaf: Attitude of blade (early observation) | Semi-erect |
| 18.   | Lemma: Anthocyanin colouration of keel | Absent                  |
| 19.   | Lemma: Anthocyanin colouration of area below apex | Absent |
| 20.   | Lemma: Anthocyanin colouration of apex | Absent                  |
| 21.   | Spikelet: Colour of stigma              | White                   |
| 22.   | Stem: Length (excluding panicle length) | Very short (105.00 cm)  |
| 23.   | Stem: Thickness                         | Medium                  |
| 24.   | Stem: Anthocyanin colouration of nodes | Absent                  |
| 25.   | Stem: Anthocyanin colouration of internodes | Absent |
| 26.   | Panicle: Length of main axis            | Medium                  |
| 27.   | Panicle: Curvature of main axis         | Dropping                |
| 28.   | Panicle: Number per plant               | Medium                  |
| 29.   | Spikelet: Colour of tip of lemma        | Yellowish               |
| 30.   | Lemma and Palea: Colour                | Straw                   |
| 31.   | Panicle: Awns                           | Absent                  |
| 32.   | Panicle: Exertion                       | Well exerted            |
| 33.   | Sterile lemma: Colour                   | Straw                   |
| 34.   | Decorticated grain: Aroma               | Absent                  |
Table 9. DNA fingerprinting of proposed variety, Uttar Sona with standard varieties (allele size in bp)

| S. No. | Markers | IR64 | MTU1010 | Annada | GB-1 | Uttar Sona | UBKVR 15 |
|--------|---------|------|---------|--------|------|------------|----------|
| 1.     | RM 495  | 148  | 148     | 148    | 148  | 160        | 148      |
| 2.     | RM 455  | 141  | 130     | 129    | 128  | 129        | 126      |
| 3.     | RM 29   | 195  | 191     | 193    | 191  | 191        | 195      |
| 4.     | RM 433  | 281  | 270     | 291    | 299  | 266        | 287      |
| 5.     | RM 7434 | 125  | 123     | 123    | 125  | 119        | 121      |
| 6.     | RM585   | 255  | 250     | 174    | 173  | 229        | 177      |
| 7.     | RM3562  | 155  | 153     | 145    | 156  | 148        | 156      |
| 8.     | RM 552  | 176  | 178     | 177    | 178  | 186        | 175      |
| 9.     | RM 418  | 288  | 288     | 315    | 298  | 291        | 296      |
| 10.    | RM 205  | 136  | 133     | 129    | 128  | 133        | 133      |
| 11.    | RM 452  | 213  | 177     | 178    | 170  | 180        | 205      |
| 12.    | RM 124  | -    | 158     | 154    | 157  | 164        | 188      |
| 13.    | RM 507  | -    | 136     | 126    | 128  | 127        | 120      |
| 14.    | RM 133  | 237  | 246     | 237    | 235  | 239        | 237      |
| 15.    | RM 162  | 216  | 214     | 215    | 213  | 214        | 214      |
| 16.    | RM 125  | 121  | 121     | 121    | 122  | 122        | 123      |
| 17.    | RM 284  | 141  | 141     | 141    | 142  | 142        | 142      |
| 18.    | RM 316  | 202  | 202     | 201    | 201  | 200        | 201      |
| 19.    | RM 215  | 128  | 126     | 113    | 113  | -          | 112      |
| 20.    | RM 277  | 126  | 120     | 122    | 121  | 120        | 122      |

![Fig. 2. DNA profile of six rice genotypes with primers RM455, RM433, RM418 and RM495; L= 100 bp molecular weight size standard.](https://doi.org/10.37992/2021.1202.045)
it from rest of the other genotypes tested in combination with other SSR markers studied. These markers were RM495, RM433, RM7434, RM585, RM3562, RM552, RM418, RM452, RM124, RM507, RM133 and RM316.

Based on the performance of the entry in West Bengal (AICRIP trials, multi-locational yield trial in West Bengal and adaptive trials at the farmers’ field) the variety was recommended by the ‘State Variety Release Committee [Ref. 706(75)-Res, dated 10.10.2018, Directorate of Agriculture, West Bengal] and forwarded by ‘State Seed Sub Committee of Crop Standards Notification and Release of Varieties for Agricultural Crops’ for release in West Bengal for cultivation of this variety during both the Boro and Kharif seasons. Subsequently the variety was notified by the ‘Central Variety Release Committee (F. No. 3-71/2019-SD.IV, dated 05.09.2019, Ministry of Agriculture and Farmers Welfare, Department of Agriculture, Cooperation and Farmers Welfare, Government of India)’ for cultivation of this variety in West Bengal.

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