IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

# Varietal Selection, Recommendation And Comparison With Crop Ideotype

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**Abstract**

An experiment, in a randomized block design, was conducted during Rabi season 2019-2020 on 12 wheat varieties with the objectives of objectively selecting plant types close to crop ideotype and precisely recommending the suitable plant types to farmers' field conditions of Deoria district in eastern Uttar Pradesh. The varieties were evaluated on 14 characters like plant height (cm), grains per spike (grain number), spike length (cm), grain yield per spike (g), grain yield per plant (g), effective tillers, spikelets per spike, biological yield per plant (g), test weight, peduncle length, flag leaf area ($cm^2$), days to maturity, moisture percentage and days to 50% flowering. Normalized cumulative ranks were used for selection. The top five varieties *viz.*, AAIDU-WL-9, AAIDU-WL-2, AAIDU-WL-5, AAIDU-WL-11 and AAIDU-WL-10 were precisely recommended to farmers of this region for cultivation. Top two varieties were compared with ideal plant type and were presented as line graph. AAIDU-WL-9 is consistently better and closer to ideal plant type than AAIDU-WL-2.

**Key words**: Crop ideotypes, Graphical presentation of comparison, Normalized cumulative ranks, Recommender system, Selection.

## Introduction

Bread wheat, (*Triticum aestivum* L. em. Thell), is a staple food of masses world-wide. However, its productivity and production is hampered by non-availability of suitable varieties suited to local field conditions of farmers and become a local limiting factor. Variety plays an important role and selection of suitable wheat variety is crucial as per local conditions of farmers' fields. That is why an experiment was designed and conducted to evaluate twelve wheat accessions/varieties under the conditions of farmland of B. R. D. P. G. College, Deoria, in eastern Uttar Pradesh, India. The objectives of this experiment were to: 1. provide a very objective selection procedure and based on this selection, 2. develop a very precise varietal recommender system so that farmers of this region get the best varieties suited to their field conditions, and 3. compare two top performers with the ideal plant type and present graphically.

## Materials and Methods

The field experiment under present investigation was conducted during Rabi season of 2019-20 at Agriculture Research farm of Baba Raghav Das Post Graduate College Deoria (U.P.). Geographically, this College is located in the eastern part of Uttar Pradesh, India. The site of experiment is located at 26.5°N latitude, 83.79°E longitude and 68 meter (223 feet) above the mean sea level. The climate of district Deoria is semi-arid with hot summer and cold winter nearly 80% of total rain fall is received during the monsoon (only up to September) with a few showers in the winter season. The meteorological data pertaining to annual rainfall, temperature (min. and max.) and relative humidity during the crop season is given in the table 1.

**Table 1: Meterological data (weekly average) during course of investigation (Rabi 2019-20).**

| Week/month | Temperature (° C) | | Relative humidity (%) | | Rainfall (mm) |
|---|---|---|---|---|---|
| | Max. | Min. | Max. | Min. | |
| **December 2019** | | | | | |
| 1st week | 22.5 | 16.75 | 72 | 54 | 0.00 |
| 2nd week | 21.25 | 15.5 | 86 | 64 | 0.53 |
| 3rd week | 16.5 | 13.25 | 78 | 64 | 0.00 |
| 4th week | 11.8 | 6.2 | 88 | 65 | 0.00 |
| **January 2020** | | | | | |
| 1st week | 20.5 | 11 | 88 | 60 | 0.00 |
| 2nd week | 19 | 9.75 | 87 | 80 | 0.00 |
| 3rd week | 20.5 | 10.25 | 86 | 78 | 0.70 |
| 4th week | 21.6 | 9.2 | 85 | 62 | 0.00 |
| **February 2020** | | | | | |
| 1st week | 22.75 | 8 | 65 | 44 | 0.00 |
| 2nd week | 24.25 | 10.75 | 74 | 57 | 0.00 |
| 3rd week | 26.75 | 12.5 | 69 | 56 | 0.00 |
| 4th week | 26 | 14.75 | 80 | 63 | 0.00 |
| **March 2020** | | | | | |
| 1st week | 28 | 16.5 | 72 | 58 | 0.00 |
| 2nd week | 27.2 | 16.4 | 74 | 50 | 0.00 |
| 3rd week | 30.5 | 15.5 | 62 | 50 | 0.00 |
| 4th week | 34.6 | 17.6 | 66 | 46 | 0.00 |
| **April 2020** | | | | | |
| 1st week | 37.5 | 18 | 38 | 12 | 0.00 |
| 2nd week | 39.75 | 21.25 | 48 | 28 | 0.00 |

The experimental materials comprised of 12 wheat genotypes, as listed in table 2, from advance lines of various pedigrees. These genotypes were procured from genetic stock available in wheat section of department of Genetics and Plant Breeding, B.R.D. P.G. College, Deoria (U.P.). The standard check (HD-2967) used in experiment is a well-adapted variety of the region.

**Table 2: List of twelve genotypes used in present investigation.**

| S. N. | Pedigree | Genotypes | S. N. | Pedigree | Genotypes |
|---|---|---|---|---|---|
| 1 | AAI-W12×VWTH-80-14 | AAIDU-WL-1 | 7 | RAJ-3765×RAJ3077 | AAIDU-WL-7 |
| 2 | K-8962×WR-1451 | AAIDU-WL-2 | 8 | K-816×HALNA | AAIDU-WL-8 |
| 3 | GW-03-02×RAJ3765 | AAIDU-WL-3 | 9 | AAI-2×U-HALNA | AAIDU-WL-9 |
| 4 | RAJ-3765×GW-03-02 | AAIDU-WL-4 | 10 | RAJ-1488×RAJ3765 | AAIDU-WL-10 |
| 5 | RAJ-4037×RAJ3765 | AAIDU-WL-5 | 11 | K-316×VWTH-08-14 | AAIDU-WL-11 |
| 6 | SAW-03-02×RAJ4026 | AAIDU-WL-6 | 12 | HD-2967 | HD-2967 |

The above wheat germplasm lines were evaluated in good soil under timely sown and irrigated conditions in a randomized block design. The entire experimental field was divided into three blocks of equal size showing three replications. Each block was divided into 12 plots of equal size.

**DATE OF SOWING:** 19 NOVEMBER 2019.

**LAYOUT DESCRIPTION:** Number of replications: 3; Gross area: 194.48 $m^2$; Net area: 100.08 $m^2$; Number of rows: 65 (5 rows of each variety); Row to row distance: 22 cm; Gross plot size: 11×17.68 m; Net plot size: 6×16.68 m.

**FERTILIZER & MANURE:** 70 kg DAP was applied as basal dose at the time of showing and 50 kg DAP was applied as top dressing 25 day after sowing.

**OBSERVATIONS RECORDED**

To observe the yield contributing traits and seed characteristics, five plants were randomly tagged to record the data. The mean values for the treatment were computed. The characters studied and techniques adopted to record the observations are 1. Plant height (cm). With the help of scale. 2. Grains per spike. By counting grains. 3. Spike length (cm). With the help of scale. 4. Grain yield per spike (gm). Weighing. 5. Grain yield per plant (gm). Weighing. 6. Number of effective tiller per plant. Counting. 7. Spikelets per spike. Counting. 8. Biological yield per plant. Weighing. In grammes. 9. Test weight (gm). Weighing. 10. Peduncle length (cm). With the help of scale. 11. Flag leaf area (cm). With the help of length and width of leaf and using correction factor. 12. Days to maturity. Counting days. 13. Moisture %. Drying. 14. Days to 50% flowering. Counting days.

**Data Analysis**

The data were compiled by taking the mean values (Table 3) of five selected plants in each plot and subjected to following non-parametric analysis:

**Ranking, normalizing and calculating normalized cumulative ranks**

A nonparametric statistical analysis, as used earlier, was carried out in two steps: 1. Calculation of ranks of each genotype and summing the ranks to find cumulative rank, and 2. Normalizing the cumulative ranks by minimum value and finding out a list of suitable genotypes by sorting the normalized cumulative ranks. The two steps are shown in two formulae: 1. CR = $\sum_{i=1}^{n} R_i$ and 2. NCR = $CR/CR_{min}$, where, CR = cumulative rank; NCR = normalized cumulative rank; R = Rank; n = number of parameters (or characters) evaluated. The value of NCR ranges from one ($CR_{min}/CR_{min}$) to $CR_{max}/CR_{min}$. The upper limit of NCR increases with number and inherent diversity of evaluated genotypes. NCR value one (1) shows the best available genotype and the maximum value shows the worst genotype. The range is an indicator of diversity. A single line formula for normalized cumulative ranks (NCR) analysis is given as $NCR = (\sum_{i=1}^{n} R_i)/(\sum_{i=1}^{n} R_i)min$. Ranking is a kind of data transformation that makes data of various parameters unit-less and hence additive.

Table 3: Average values based on the three replications.

| S.N. | GENOTYPE (Down↓) (Sort order Right→) | Pl Ht | GPS | Spike Length | GYPS | GYPP | ET | Spikelets /Spike | BYPP | TW | Peduncle Length | FLA | D2M | Moisture% | D2-50%F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 1 | AAIDU-WL-1 | 99.13 | 59.33 | 11.27 | 2.53 | 13 | 6.47 | 18.07 | 33.6 | 46.33 | 48.93 | 54.98 | 106 | 11.43 | 76 |
| 2 | AAIDU-WL-2 | 98.27 | 63.2 | 12.2 | 3.27 | 16.33 | 7.07 | 21.6 | 37.73 | 45.67 | 49.73 | 49.96 | 112 | 10.93 | 82 |
| 3 | AAIDU-WL-3 | 94.47 | 44.67 | 9.4 | 2.47 | 13.67 | 7.6 | 16.13 | 32.07 | 47.33 | 52.93 | 43.54 | 101 | 11.63 | 71 |
| 4 | AAIDU-WL-4 | 89.93 | 53.27 | 10.67 | 3.27 | 10.87 | 8.47 | 17.67 | 34.27 | 45.67 | 47.27 | 49.63 | 106.33 | 10.6 | 76.33 |
| 5 | AAIDU-WL-5 | 104.4 | 49.07 | 12.4 | 2.53 | 13.53 | 6.2 | 21.47 | 37 | 56.33 | 55.93 | 49.19 | 107.33 | 10.97 | 77.33 |
| 6 | AAIDU-WL-6 | 115.93 | 40.73 | 10.53 | 2.6 | 12.53 | 6.33 | 17.73 | 30.13 | 51 | 56.93 | 46.08 | 114 | 11.27 | 84 |
| 7 | AAIDU-WL-7 | 89 | 47.73 | 10.27 | 2.67 | 10.4 | 7.33 | 17.93 | 26.27 | 45 | 50.2 | 45.93 | 105 | 10.23 | 75 |
| 8 | AAIDU-WL-8 | 82.2 | 66.6 | 11.53 | 3.67 | 13 | 6.13 | 21.4 | 31 | 44.67 | 36.07 | 51.77 | 102.33 | 11.7 | 72.33 |
| 9 | AAIDU-WL-9 | 102 | 59.47 | 11.93 | 3.67 | 15.13 | 5.73 | 19.87 | 32.6 | 54.33 | 42.07 | 41.82 | 100.67 | 12.1 | 70.67 |
| 10 | AAIDU-WL-10 | 97 | 55.6 | 11.27 | 3.4 | 14.27 | 6.8 | 19.47 | 31.67 | 48.33 | 56.67 | 51.27 | 107.33 | 11.5 | 77.33 |
| 11 | AAIDU-WL-11 | 97.67 | 61.53 | 11.4 | 3.27 | 13.6 | 6.13 | 19.93 | 30.47 | 48 | 50.6 | 48.78 | 107.67 | 10.33 | 77.67 |
| 12 | HD2967 | 95.4 | 56.2 | 10.93 | 3 | 15.27 | 7 | 21.47 | 36.8 | 48 | 44.73 | 48.42 | 115 | 12 | 85 |

(0 = Descending, 1 = Ascending)

From sort order as given in table 3 onwards, it is clear that ten characters in desirable plant types were selected for more i.e., for tall plants, more grains per spike, long spike, more grain yield per spike, more grain yield per plant, more effective tillers, more spikelets per spike, more biological yield per plant, more test weight and more peduncle length for fully exerted spike, and less flag leaf area, early maturity, less moisture percentage for long term storage, and early flowering.

**Results**

The results of the analysis are given in table 4.

Table 4: Ranks, CR and NCR values that give Table 5 on sorting on CR or NCR.

| S.N. | GENOTYPE (Down↓) (Sort order Right→) | Pl Ht | GPS | Spike Length | GYPS | GYPP | ET | Spikelets /Spike | BYPP | TW | Peduncle Length | FLA | D2M | Moisture% | D2-50%F | CR | NCR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | | |
| 1 | AAIDU-WL-1 | 4 | 5 | 6 | 10 | 8 | 7 | 8 | 5 | 8 | 8 | 12 | 5 | 7 | 5 | 98 | 1.46 |
| 2 | AAIDU-WL-2 | 5 | 2 | 2 | 4 | 1 | 4 | 1 | 1 | 9 | 7 | 9 | 10 | 4 | 10 | 69 | 1.05 |
| 3 | AAIDU-WL-3 | 9 | 11 | 12 | 12 | 5 | 2 | 12 | 7 | 7 | 4 | 2 | 2 | 9 | 2 | 96 | 1.45 |
| 4 | AAIDU-WL-4 | 10 | 8 | 9 | 4 | 11 | 1 | 11 | 4 | 9 | 9 | 8 | 6 | 3 | 6 | 99 | 1.5 |
| 5 | AAIDU-WL-5 | 2 | 9 | 1 | 10 | 7 | 9 | 2 | 2 | 1 | 3 | 7 | 7 | 5 | 7 | 72 | 1.09 |
| 6 | AAIDU-WL-6 | 1 | 12 | 10 | 9 | 10 | 8 | 10 | 11 | 3 | 1 | 4 | 11 | 6 | 11 | 107 | 1.62 |
| 7 | AAIDU-WL-7 | 11 | 10 | 11 | 8 | 12 | 3 | 9 | 12 | 11 | 6 | 3 | 4 | 1 | 4 | 105 | 1.59 |
| 8 | AAIDU-WL-8 | 12 | 1 | 4 | 1 | 8 | 10 | 4 | 9 | 12 | 12 | 11 | 3 | 10 | 3 | 100 | 1.52 |
| 9 | AAIDU-WL-9 | 3 | 4 | 3 | 1 | 3 | 12 | 6 | 6 | 2 | 11 | 1 | 1 | 12 | 1 | 66 | 1 |
| 10 | AAIDU-WL-10 | 7 | 7 | 6 | 3 | 4 | 6 | 7 | 8 | 4 | 2 | 10 | 7 | 8 | 7 | 86 | 1.3 |
| 11 | AAIDU-WL-11 | 6 | 3 | 5 | 4 | 6 | 10 | 5 | 10 | 5 | 5 | 6 | 9 | 2 | 9 | 85 | 1.29 |
| 12 | HD2967 | 8 | 6 | 8 | 7 | 2 | 5 | 2 | 3 | 5 | 10 | 5 | 12 | 11 | 12 | 96 | 1.45 |

Table 5: Varietal preference order based on 14 parameters analyzed.

| S.N. | GENOTYPE (Down↓) (Sort order Right→) | Pl Ht | GPS | Spike Length | GYPS | GYPP | ET | Spikelets /Spike | BYPP | TW | Peduncle Length | FLA | D2M | Moisture% | D2-50%F | CR | NCR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | | |
| 1 | AAIDU-WL-9 | 3 | 4 | 3 | 1 | 3 | 12 | 6 | 6 | 2 | 11 | 1 | 1 | 12 | 1 | 66 | 1 |
| 2 | AAIDU-WL-2 | 5 | 2 | 2 | 4 | 1 | 4 | 1 | 1 | 9 | 7 | 9 | 10 | 4 | 10 | 69 | 1.05 |
| 3 | AAIDU-WL-5 | 2 | 9 | 1 | 10 | 7 | 9 | 2 | 2 | 1 | 3 | 7 | 7 | 5 | 7 | 72 | 1.09 |
| 4 | AAIDU-WL-11 | 6 | 3 | 5 | 4 | 6 | 10 | 5 | 10 | 5 | 5 | 6 | 9 | 2 | 9 | 85 | 1.29 |
| 5 | AAIDU-WL-10 | 7 | 7 | 6 | 3 | 4 | 6 | 7 | 8 | 4 | 2 | 10 | 7 | 8 | 7 | 86 | 1.3 |
| 6 | AAIDU-WL-3 | 9 | 11 | 12 | 12 | 5 | 2 | 12 | 7 | 7 | 4 | 2 | 2 | 9 | 2 | 96 | 1.45 |
| 7 | HD2967 | 8 | 6 | 8 | 7 | 2 | 5 | 2 | 3 | 5 | 10 | 5 | 12 | 11 | 12 | 96 | 1.45 |
| 8 | AAIDU-WL-1 | 4 | 5 | 6 | 10 | 8 | 7 | 8 | 5 | 8 | 8 | 12 | 5 | 7 | 5 | 98 | 1.46 |
| 9 | AAIDU-WL-4 | 10 | 8 | 9 | 4 | 11 | 1 | 11 | 4 | 9 | 9 | 8 | 6 | 3 | 6 | 99 | 1.5 |
| 10 | AAIDU-WL-8 | 12 | 1 | 4 | 1 | 8 | 10 | 4 | 9 | 12 | 12 | 11 | 3 | 10 | 3 | 100 | 1.52 |
| 11 | AAIDU-WL-7 | 11 | 10 | 11 | 8 | 12 | 3 | 9 | 12 | 11 | 6 | 3 | 4 | 1 | 4 | 105 | 1.59 |
| 12 | AAIDU-WL-6 | 1 | 12 | 10 | 9 | 10 | 8 | 10 | 11 | 3 | 1 | 4 | 11 | 6 | 11 | 107 | 1.62 |

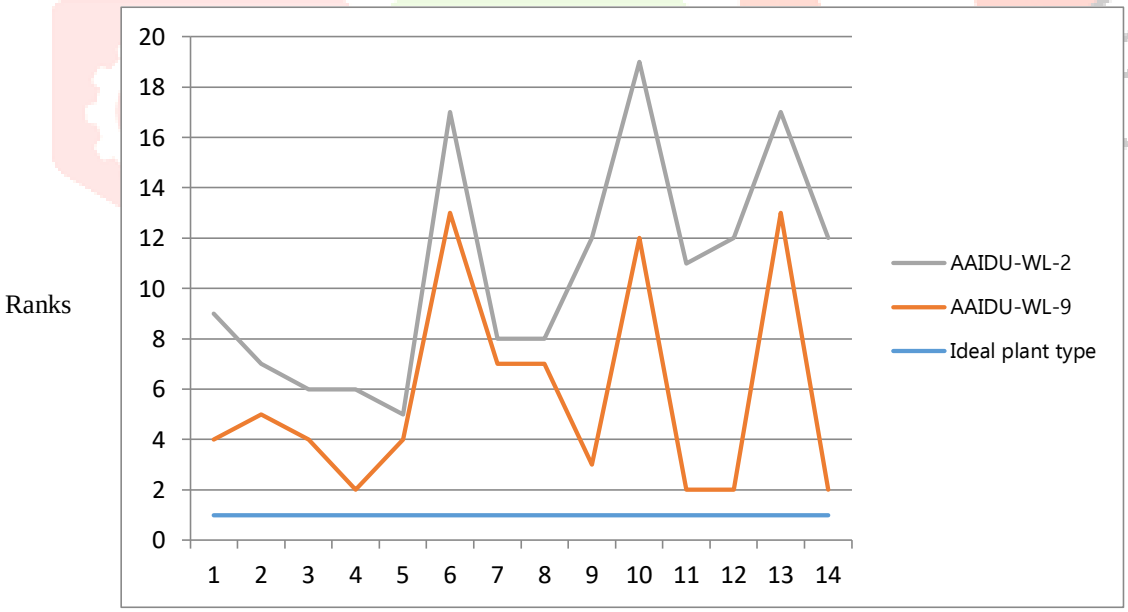
Based on the sorted NCR values, as shown in Table 5, the top five varieties namely, AAIDU-WL-9, AAIDU-WL-2, AAIDU-WL-5, AAIDU-WL-11 and AAIDU-WL-10 were precisely recommended to farmers of this region for cultivation. The standard check variety (HD-2967) is occupying seventh position among 12 evaluated germplasm. Hence, upper six could be tried at farmers' fields next year. The most promising germplasm (AAIDU-WL-9) can be further improved by paying attention to parameters 6 (effective tillers, ranking 12), 10 (peduncle length, ranking 11) and 13 (moisture %, ranking 12). Spikelets per spike and biological yield per plant could also be given attention for further improvement.

**Precis(e) varietal recommender system**

Quite often, due to shortage of time and resources, we have no option but to be very precis(e) in our presentation and recommendation. This happens during paper presentations, poster presentations, paper writings and demonstrations to farmers. This problem comes while presenting the varietal screening data especially when a large number of varieties/ genotypes/ accessions are tried in multi-location trials. Under such a scenario, the raw data (e.g., Table 3) and the ranking data (Table 4) could be combined into a single table as given in Table 6. After sorting the table 6 on CR or NCR, we get Table 7. To be even more precis(e) than the above suggestions, we can give only one table (Table 7) to sum up whole findings. When the numbers of entries in the trials are large enough to present in a single page table, then only a single page table could be presented showing only the top performers. This precis(e)ness saves paper, time and money. This experiment and the paper got inspiration from crop ideotype concept of Donald (1968). Similar types of non-parametric analyses were carried out by Singh et. al. 2018, Singh and Tiwari 2020 and Yadav et. al. 2020.

The ranks of twelve genotypes for fourteen characters are presented in tables 4-7. Wide range of variation in ranks of genotypes was observed for all the characters under study. From the same data set, late varieties can also be selected just by changing the sort order. This way a plant breeder can design the crop ideotype of his/her choice. The ranks of AAIDU-WL-9 are more close to the ideal plant type in comparison to AAIDU-WL-2 (Tables showing ranks and Figure 1). Considering given criteria genotype **AAIDU-WL-9** performed the best among all genotypes. AADU-WL-9 could be further improved by paying attention to its peduncle length, grains/ear and harvest index. This way, the NCR analysis seems very efficient in finding out **"what needs to be done"** in plant breeding. If we include all types of plant genetic resources in our NCR analysis, then we would be able to locate **"from where to get the needful genes"** for further improvements.

**Figure 1: The graphical presentation of comparing the two top performers with the Ideal Plant Type.**




| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ideal plant type | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| AAIDU-WL-9 | 3 | 4 | 3 | 1 | 3 | 12 | 6 | 6 | 2 | 11 | 1 | 1 | 12 | 1 |
| AAIDU-WL-2 | 5 | 2 | 2 | 4 | 1 | 4 | 1 | 1 | 9 | 7 | 9 | 10 | 4 | 10 |

The genotypes AAIDU-WL-9 and AAIDU-WL-2 are the top performing genotypes considering all the fourteen parameters together. These varieties could also be recommended for cultivation. It would be better to mention the sort order in the consolidated data table for the sake of clarity. When the treatments/entries in trials are large enough to present in a single page table then only a single page table could be presented showing only the top performers. This precis(e)ness saves paper, time and money.

**Table 6: Precis(e) varietal recommendation: combining consolidated data and ranks.**

| S.N. | GENOTYPE (Down↓) (Sort order Right→) | Pl Ht | GPS | Spike Length | GYPS | GYPP | ET | Spikelets /Spike | BYPP | TW | Peduncle Length | FLA | D2M | Moisture% | D2-50%F | CR | NCR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | | |
| 1 | AAIDU-WL-1 | 99.13 (4) | 59.33 (5) | 11.27 (6) | 2.53 (10) | 13 (8) | 6.47 (7) | 18.07 (8) | 33.6 (5) | 46.33 (8) | 48.93 (8) | 54.98 (12) | 106 (5) | 11.43 (7) | 76 (5) | 98 | 1.46 |
| 2 | AAIDU-WL-2 | 98.27 (5) | 63.2 (2) | 12.2 (2) | 3.27 (4) | 16.33 (1) | 7.07 (4) | 21.6 (1) | 37.73 (1) | 45.67 (9) | 49.73 (7) | 49.96 (9) | 112 (10) | 10.93 (4) | 82 (10) | 69 | 1.05 |
| 3 | AAIDU-WL-3 | 94.47 (9) | 44.67 (11) | 9.4 (12) | 2.47 (12) | 13.67 (5) | 7.6 (2) | 16.13 (12) | 32.07 (7) | 47.33 (7) | 52.93 (4) | 43.54 (2) | 101 (2) | 11.63 (9) | 71 (2) | 96 | 1.45 |
| 4 | AAIDU-WL-4 | 89.93 (10) | 53.27 (8) | 10.67 (9) | 3.27 (4) | 10.87 (11) | 8.47 (1) | 17.67 (11) | 34.27 (4) | 45.67 (9) | 47.27 (9) | 49.63 (8) | 106.33 (6) | 10.6 (3) | 76.33 (6) | 99 | 1.5 |
| 5 | AAIDU-WL-5 | 104.4 (2) | 49.07 (9) | 12.4 (1) | 2.53 (10) | 13.53 (7) | 6.2 (9) | 21.47 (2) | 37 (2) | 56.33 (1) | 55.93 (3) | 49.19 (7) | 107.33 (7) | 10.97 (5) | 77.33 (7) | 72 | 1.09 |
| 6 | AAIDU-WL-6 | 115.93 (1) | 40.73 (12) | 10.53 (10) | 2.6 (9) | 12.53 (10) | 6.33 (8) | 17.73 (10) | 30.13 (11) | 51 (3) | 56.93 (1) | 46.08 (4) | 114 (11) | 11.27 (6) | 84 (11) | 107 | 1.62 |
| 7 | AAIDU-WL-7 | 89 (11) | 47.73 (10) | 10.27 (11) | 2.67 (8) | 10.4 (12) | 7.33 (3) | 17.93 (9) | 26.27 (12) | 45 (11) | 50.2 (6) | 45.93 (3) | 105 (4) | 10.23 (1) | 75 (4) | 105 | 1.59 |
| 8 | AAIDU-WL-8 | 82.2 (12) | 66.6 (1) | 11.53 (4) | 3.67 (1) | 13 (8) | 6.13 (10) | 21.4 (4) | 31 (9) | 44.67 (12) | 36.07 (12) | 51.77 (11) | 102.33 (3) | 11.7 (10) | 72.33 (3) | 100 | 1.52 |
| 9 | AAIDU-WL-9 | 102 (3) | 59.47 (4) | 11.93 (3) | 3.67 (1) | 15.13 (3) | 5.73 (12) | 19.87 (6) | 32.6 (6) | 54.33 (2) | 42.07 (11) | 41.82 (1) | 100.67 (1) | 12.1 (12) | 70.67 (1) | 66 | 1 |
| 10 | AAIDU-WL-10 | 97 (7) | 55.6 (7) | 11.27 (6) | 3.4 (3) | 14.27 (4) | 6.8 (6) | 19.47 (7) | 31.67 (8) | 48.33 (4) | 56.67 (2) | 51.27 (10) | 107.33 (7) | 11.5 (8) | 77.33 (7) | 86 | 1.3 |
| 11 | AAIDU-WL-11 | 97.67 (6) | 61.53 (3) | 11.4 (5) | 3.27 (4) | 13.6 (6) | 6.13 (10) | 19.93 (5) | 30.47 (10) | 48 (5) | 50.6 (5) | 48.78 (6) | 107.67 (9) | 10.33 (2) | 77.67 (9) | 85 | 1.29 |
| 12 | HD2967 | 95.4 (8) | 56.2 (6) | 10.93 (8) | 3 (7) | 15.27 (2) | 7 (5) | 21.47 (2) | 36.8 (3) | 48 (5) | 44.73 (10) | 48.42 (5) | 115 (12) | 12 (11) | 85 (12) | 96 | 1.45 |

**Table 7: Precis(e) varietal recommendation: sorting on CR or NCR values.**

| S.N. | GENOTYPE (Down↓) (Sort order Right→) | Pl Ht | GPS | Spike Length | GYPS | GYPP | ET | Spikelets /Spike | BYPP | TW | Peduncle Length | FLA | D2M | Moisture% | D2-50%F | CR | NCR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | | |
| 1 | AAIDU-WL-9 | 102 (3) | 59.47 (4) | 11.93 (3) | 3.67 (1) | 15.13 (3) | 5.73 (12) | 19.87 (6) | 32.6 (6) | 54.33 (2) | 42.07 (11) | 41.82 (1) | 100.67 (1) | 12.1 (12) | 70.67 (1) | 66 | 1 |
| 2 | AAIDU-WL-2 | 98.27 (5) | 63.2 (2) | 12.2 (2) | 3.27 (4) | 16.33 (1) | 7.07 (4) | 21.6 (1) | 37.73 (1) | 45.67 (9) | 49.73 (7) | 49.96 (9) | 112 (10) | 10.93 (4) | 82 (10) | 69 | 1.05 |
| 3 | AAIDU-WL-5 | 104.4 (2) | 49.07 (9) | 12.4 (1) | 2.53 (10) | 13.53 (7) | 6.2 (9) | 21.47 (2) | 37 (2) | 56.33 (1) | 55.93 (3) | 49.19 (7) | 107.33 (7) | 10.97 (5) | 77.33 (7) | 72 | 1.09 |
| 4 | AAIDU-WL-11 | 97.67 (6) | 61.53 (3) | 11.4 (5) | 3.27 (4) | 13.6 (6) | 6.13 (10) | 19.93 (5) | 30.47 (10) | 48 (5) | 50.6 (5) | 48.78 (6) | 107.67 (9) | 10.33 (2) | 77.67 (9) | 85 | 1.29 |
| 5 | AAIDU-WL-10 | 97 (7) | 55.6 (7) | 11.27 (6) | 3.4 (3) | 14.27 (4) | 6.8 (6) | 19.47 (7) | 31.67 (8) | 48.33 (4) | 56.67 (2) | 51.27 (10) | 107.33 (7) | 11.5 (8) | 77.33 (7) | 86 | 1.3 |
| 6 | AAIDU-WL-3 | 94.47 (9) | 44.67 (11) | 9.4 (12) | 2.47 (12) | 13.67 (5) | 7.6 (2) | 16.13 (12) | 32.07 (7) | 47.33 (7) | 52.93 (4) | 43.54 (2) | 101 (2) | 11.63 (9) | 71 (2) | 96 | 1.45 |
| 7 | HD2967 | 95.4 (8) | 56.2 (6) | 10.93 (8) | 3 (7) | 15.27 (2) | 7 (5) | 21.47 (2) | 36.8 (3) | 48 (5) | 44.73 (10) | 48.42 (5) | 115 (12) | 12 (11) | 85 (12) | 96 | 1.45 |
| 8 | AAIDU-WL-1 | 99.13 (4) | 59.33 (5) | 11.27 (6) | 2.53 (10) | 13 (8) | 6.47 (7) | 18.07 (8) | 33.6 (5) | 46.33 (8) | 48.93 (8) | 54.98 (12) | 106 (5) | 11.43 (7) | 76 (5) | 98 | 1.46 |
| 9 | AAIDU-WL-4 | 89.93 (10) | 53.27 (8) | 10.67 (9) | 3.27 (4) | 10.87 (11) | 8.47 (1) | 17.67 (11) | 34.27 (4) | 45.67 (9) | 47.27 (9) | 49.63 (8) | 106.33 (6) | 10.6 (3) | 76.33 (6) | 99 | 1.5 |
| 10 | AAIDU-WL-8 | 82.2 (12) | 66.6 (1) | 11.53 (4) | 3.67 (1) | 13 (8) | 6.13 (10) | 21.4 (4) | 31 (9) | 44.67 (12) | 36.07 (12) | 51.77 (11) | 102.33 (3) | 11.7 (10) | 72.33 (3) | 100 | 1.52 |
| 11 | AAIDU-WL-7 | 89 (11) | 47.73 (10) | 10.27 (11) | 2.67 (8) | 10.4 (12) | 7.33 (3) | 17.93 (9) | 26.27 (12) | 45 (11) | 50.2 (6) | 45.93 (3) | 105 (4) | 10.23 (1) | 75 (4) | 105 | 1.59 |
| 12 | AAIDU-WL-6 | 115.93 (1) | 40.73 (12) | 10.53 (10) | 2.6 (9) | 12.53 (10) | 6.33 (8) | 17.73 (10) | 30.13 (11) | 51 (3) | 56.93 (1) | 46.08 (4) | 114 (11) | 11.27 (6) | 84 (11) | 107 | 1.62 |

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