

## Supplementary Materials

**Table S1.** Description of the 174 rice genotypes analyzed in the study.

| Sample | Plant_ID   | Name                   | Origin      | Subpopulations of the study       | Sample order in STRUCTURE <sup>a</sup> | Sample classification in two major subpopulations <sup>b</sup> |
|--------|------------|------------------------|-------------|-----------------------------------|--|--|
| RG-2   | Clor 12153 | Quinimpol              | Philippines | Admixture                         | 115                                    | <i>Japonica</i>  |
| RG-4   | Clor 12234 | Long Gnar Jim          | US          | Pop 3/Tropical <i>Japonica</i> -1 | 92                                     | <i>Japonica</i>  |
| RG-6   | Clor 12244 | Creole Bred            | US          | Admixture                         | 39                                     | <i>Japonica</i>  |
| RG-9   | Clor 2490  | Karang Serang          | Indonesia   | Admixture                         | 77                                     | <i>Japonica</i>  |
| RG-11  | Clor 7404  | Kin Shan Zim           | China       | Pop 6/ <i>Indica</i>              | 84                                     | <i>Indica</i>  |
| RG-14  | Clor 9403  | Century Patna Original | US          | Pop 3/Tropical <i>Japonica</i> -1 | 29                                     | <i>Japonica</i>  |
| RG-15  | PI 127076  | Spin Mere              | Afghanistan | Pop 1/Aus                         | 135                                    | <i>Indica</i>  |
| RG-18  | PI 160530  | Pan Ju                 | China       | Pop 6/ <i>Indica</i>              | 110                                    | <i>Indica</i>  |
| RG-19  | PI 161567  | Criollo Chivacoa 2     | Venezuela   | Admixture                         | 40                                     | <i>Japonica</i>  |
| RG-21  | PI 180060  | Dhala Shaitta          | Bangladesh  | Pop 1/Aus                         | 44                                     | <i>Indica</i>  |
| RG-23  | PI 199553  | Secano do Brazil       | El Salvador | Pop 2/Tropical <i>Japonica</i> -2 | 125                                    | <i>Japonica</i>  |
| RG-24  | PI 208447  | Early No. 1            | Nepal       | Pop 6/ <i>Indica</i>              | 59                                     | <i>Indica</i>  |
| RG-28  | PI 223612  | Sel. No. 388           | Uruguay     | Admixture                         | 126                                    | <i>Japonica</i>  |
| RG-29  | PI 224605  | Sigadis                | Indonesia   | Pop 5/Temperate <i>Japonica</i>   | 131                                    | <i>Japonica</i>  |
| RG-30  | PI 226204  | SHIMIZU MOCHI          | Japan       | Pop 5/Temperate <i>Japonica</i>   | 129                                    | <i>Japonica</i>  |
| RG-31  | PI 229262  | N 32                   | India       | Pop 1/Aus                         | 100                                    | <i>Indica</i>  |
| RG-33  | PI 238190  | Charmarumi             | India       | Pop 1/Aus                         | 30                                     | <i>Indica</i>  |
| RG-34  | PI 240638  | Dular                  | India       | Pop 1/Aus                         | 54                                     | <i>Indica</i>  |
| RG-37  | PI 277414  | Red Khosha Cerma       | Afghanistan | Admixture                         | 117                                    | <i>Japonica</i>  |

|       |           |                    |            |                                   |     |                 |
|-------|-----------|--------------------|------------|-----------------------------------|-----|-----------------|
| RG-39 | PI 283681 | Hashikalmi Aus     | Bangladesh | Pop 1/Aus                         | 66  | <i>Indica</i>   |
| RG-40 | PI 283682 | Kataktara Aus      | Bangladesh | Pop 1/Aus                         | 81  | <i>Indica</i>   |
| RG-42 | PI 291608 | WC 4443            | Bolivia    | Admixture                         | 174 | Admixture       |
| RG-43 | PI 294423 | GHRAIBA            | Iraq       | Pop 1/Aus                         | 65  | <i>Indica</i>   |
| RG-44 | PI 297569 | Dharial            | Bangladesh | Pop 1/Aus                         | 45  | <i>Indica</i>   |
| RG-48 | PI 369813 | Samanis            | Suriname   | Pop 2/Tropical <i>Japonica</i> -2 | 123 | <i>Japonica</i> |
| RG-49 | PI 373053 | Bala               | India      | Admixture                         | 18  | <i>Indica</i>   |
| RG-51 | PI 373232 | Khao Phoi          | Laos       | Admixture                         | 82  | <i>Indica</i>   |
| RG-52 | PI 373347 | Karayal            | Sri Lanka  | Pop 1/Aus                         | 78  | <i>Indica</i>   |
| RG-53 | PI 373403 | ARC 6578           | India      | Pop 1/Aus                         | 10  | <i>Indica</i>   |
| RG-55 | PI 373537 | ARC 10638          | India      | Pop 6/ <i>Indica</i>              | 9   | <i>Indica</i>   |
| RG-56 | PI 373777 | C 8447             | Indonesia  | Pop 2/Tropical <i>Japonica</i> -2 | 25  | <i>Japonica</i> |
| RG-57 | PI 373779 | Tia Heret          | Indonesia  | Admixture                         | 142 | <i>Japonica</i> |
| RG-60 | PI 373816 | Padi Pohon Batu    | Malaysia   | Admixture                         | 109 | <i>Japonica</i> |
| RG-62 | PI 376252 | Pelu               | India      | Pop 1/Aus                         | 111 | <i>Indica</i>   |
| RG-65 | PI 385344 | Ratna              | India      | Pop 6/ <i>Indica</i>              | 116 | <i>Indica</i>   |
| RG-67 | PI 385529 | Jhona              | Pakistan   | Pop 1/Aus                         | 75  | <i>Indica</i>   |
| RG-68 | PI 385578 | Sufaida            | Pakistan   | Pop 1/Aus                         | 138 | <i>Indica</i>   |
| RG-70 | PI 385621 | Mahlar             | Pakistan   | Pop 1/Aus                         | 96  | <i>Indica</i>   |
| RG-73 | PI 385849 | Ziri               | Pakistan   | Pop 1/Aus                         | 168 | <i>Indica</i>   |
| RG-74 | PI 385888 | Sathra             | Pakistan   | Pop 1/Aus                         | 124 | <i>Indica</i>   |
| RG-75 | PI 389037 | Ai Chueh Ta Pai Ku | Taiwan     | Pop 6/ <i>Indica</i>              | 1   | <i>Indica</i>   |
| RG-77 | PI 389267 | Heo Trang          | Vietnam    | Pop 6/ <i>Indica</i>              | 67  | <i>Indica</i>   |
| RG-78 | PI 389876 | Sipirasikkam       | Indonesia  | Pop 2/Tropical <i>Japonica</i> -2 | 133 | <i>Japonica</i> |
| RG-79 | PI 389879 | Sigoendaba         | Indonesia  | Admixture                         | 132 | <i>Japonica</i> |

|        |           |                    |            |                                   |     |                 |
|--------|-----------|--------------------|------------|-----------------------------------|-----|-----------------|
| RG-80  | PI 389945 | Angkrang           | Cambodia   | Pop 6/ <i>Indica</i>              | 7   | <i>Indica</i>   |
| RG-81  | PI 389960 | Srav Prapay        | Cambodia   | Pop 6/ <i>Indica</i>              | 136 | <i>Indica</i>   |
| RG-83  | PI 391827 | Lantjang           | Indonesia  | Pop 6/ <i>Indica</i>              | 91  | <i>Indica</i>   |
| RG-84  | PI 391936 | Ali Combo          | Madagascar | Pop 6/ <i>Indica</i>              | 5   | <i>Indica</i>   |
| RG-85  | PI 391943 | Sabharaj           | Bangladesh | Pop 6/ <i>Indica</i>              | 121 | <i>Indica</i>   |
| RG-86  | PI 392170 | Torh               | Pakistan   | Admixture                         | 144 | <i>Indica</i>   |
| RG-87  | PI 392217 | Sugdasi            | Pakistan   | Pop 1/Aus                         | 140 | <i>Indica</i>   |
| RG-90  | PI 392677 | ASWINA 330         | Bangladesh | Pop 1/Aus                         | 13  | <i>Indica</i>   |
| RG-92  | PI 393114 | DNJ 151            | Bangladesh | Pop 1/Aus                         | 52  | <i>Indica</i>   |
| RG-94  | PI 400042 | AS 46              | India      | Pop 1/Aus                         | 12  | <i>Indica</i>   |
| RG-95  | PI 400586 | Putih Montor       | Indonesia  | Admixture                         | 114 | <i>Japonica</i> |
| RG-96  | PI 400587 | Gendjah Banten     | Indonesia  | Pop 6/ <i>Indica</i>              | 63  | <i>Indica</i>   |
| RG-98  | PI 400662 | Janeri             | Nepal      | Pop 6/ <i>Indica</i>              | 72  | <i>Indica</i>   |
| RG-101 | PI 400773 | Vary Vato 275      | Madagascar | Admixture                         | 154 | <i>Indica</i>   |
| RG-105 | PI 400782 | Bengaly Morino 120 | Madagascar | Admixture                         | 20  | <i>Indica</i>   |
| RG-107 | PI 401750 | Kuning Tinggi      | Indonesia  | Pop 3/Tropical <i>Japonica</i> -1 | 89  | <i>Japonica</i> |
| RG-109 | PI 402634 | Koi Murali         | India      | Pop 1/Aus                         | 85  | <i>Indica</i>   |
| RG-111 | PI 402691 | Trandeup Kandir    | Cambodia   | Pop 1/Aus                         | 145 | <i>Indica</i>   |
| RG-112 | PI 402720 | Angana             | India      | Pop 1/Aus                         | 169 | <i>Indica</i>   |
| RG-113 | PI 402747 | Banajira           | Bangladesh | Pop 1/Aus                         | 19  | <i>Indica</i>   |
| RG-114 | PI 402804 | Brondol            | Indonesia  | Admixture                         | 24  | <i>Japonica</i> |
| RG-117 | PI 403091 | DJ 53              | Bangladesh | Pop 1/Aus                         | 49  | <i>Indica</i>   |
| RG-118 | PI 403109 | DJ 90              | Bangladesh | Pop 1/Aus                         | 50  | <i>Indica</i>   |
| RG-119 | PI 403114 | DJ 102             | Bangladesh | Pop 1/Aus                         | 48  | <i>Indica</i>   |
| RG-120 | PI 403160 | DM 55              | Bangladesh | Pop 1/Aus                         | 51  | <i>Indica</i>   |

|        |           |                   |             |                                   |     |                 |
|--------|-----------|-------------------|-------------|-----------------------------------|-----|-----------------|
| RG-121 | PI 403287 | DV 85             | Bangladesh  | Pop 1/Aus                         | 56  | <i>Indica</i>   |
| RG-123 | PI 403310 | DV 132            | Bangladesh  | Pop 1/Aus                         | 55  | <i>Indica</i>   |
| RG-130 | PI 412790 | Daudzai Field Mix | Pakistan    | Pop 1/Aus                         | 41  | <i>Indica</i>   |
| RG-137 | PI 413802 | Bengawan          | Indonesia   | Pop 6/ <i>Indica</i>              | 21  | <i>Indica</i>   |
| RG-138 | PI 413989 | Sug               | India       | Pop 5/Temperate <i>Japonica</i>   | 139 | <i>Japonica</i> |
| RG-148 | PI 431292 | Akabona           | Pakistan    | Pop 6/ <i>Indica</i>              | 2   | <i>Indica</i>   |
| RG-150 | PI 433833 | Aus 8             | Bangladesh  | Admixture                         | 14  | <i>Indica</i>   |
| RG-154 | PI 439078 | Ngoba             | India       | Pop 6/ <i>Indica</i>              | 104 | <i>Indica</i>   |
| RG-159 | PI 494105 | M202              | US          | Admixture                         | 94  | <i>Japonica</i> |
| RG-160 | PI 497682 | IR64              | Philippines | Pop 6/ <i>Indica</i>              | 71  | <i>Indica</i>   |
| RG-178 | PI 575134 | Bak Tushi         | Bangladesh  | Pop 1/Aus                         | 17  | <i>Indica</i>   |
| RG-179 | PI 575201 | Gambir            | Bangladesh  | Pop 1/Aus                         | 62  | <i>Indica</i>   |
| RG-181 | PI 575212 | Ghorbhai          | Bangladesh  | Pop 1/Aus                         | 64  | <i>Indica</i>   |
| RG-182 | PI 575217 | Shoni             | Bangladesh  | Pop 1/Aus                         | 130 | <i>Indica</i>   |
| RG-186 | PI 584569 | FIROOZ            | Iran        | Pop 4/Aromatic                    | 61  | <i>Japonica</i> |
| RG-189 | PI 584625 | Ak Tokhum         | Azerbaijan  | Admixture                         | 4   | Admixture       |
| RG-192 | PI 585042 | EMBRAPA 1200      | Brazil      | Pop 3/Tropical <i>Japonica</i> -1 | 60  | <i>Japonica</i> |
| RG-193 | PI 593892 | Jefferson         | US          | Pop 3/Tropical <i>Japonica</i> -1 | 74  | <i>Japonica</i> |
| RG-226 | PI 67150  | Mushkan           | India       | Pop 4/Aromatic                    | 99  | <i>Japonica</i> |
| RG-237 | PI 231642 | Caucasica         | Russia      | Pop 5/Temperate <i>Japonica</i>   | 27  | <i>Japonica</i> |
| RG-257 | PI 277417 | Shevkati Kundry   | Azerbaijan  | Pop 1/Aus                         | 128 | <i>Indica</i>   |
| RG-259 | PI 282171 | ARPA SHALI        | Uzbekistan  | Pop 5/Temperate <i>Japonica</i>   | 11  | <i>Japonica</i> |
| RG-263 | PI 282208 | Uz Rosz 17        | Uzbekistan  | Pop 5/Temperate <i>Japonica</i>   | 151 | <i>Japonica</i> |
| RG-264 | PI 282210 | UZ ROSZ 269       | Uzbekistan  | Pop 5/Temperate <i>Japonica</i>   | 147 | <i>Japonica</i> |
| RG-266 | PI 282212 | Uz Rosz 2832      | Uzbekistan  | Admixture                         | 152 | <i>Japonica</i> |

|        |           |                         |             |                                   |     |                 |
|--------|-----------|-------------------------|-------------|-----------------------------------|-----|-----------------|
| RG-269 | PI 291427 | Uz Rosz M9              | Uzbekistan  | Pop 5/Temperate <i>Japonica</i>   | 153 | <i>Japonica</i> |
| RG-276 | PI 346926 | Nahodka                 | NA          | Admixture                         | 101 | <i>Japonica</i> |
| RG-277 | PI 346927 | VILKID ZIRE             | NA          | Pop 5/Temperate <i>Japonica</i>   | 155 | <i>Japonica</i> |
| RG-279 | PI 346932 | KUBAN 3                 | Russia      | Pop 5/Temperate <i>Japonica</i>   | 88  | <i>Japonica</i> |
| RG-280 | PI 348904 | Uz Ros 275              | Uzbekistan  | Pop 5/Temperate <i>Japonica</i>   | 149 | <i>Japonica</i> |
| RG-283 | PI 348909 | SADRI MASALINSKIJ       | Azerbaijan  | Pop 4/Aromatic                    | 122 | <i>Japonica</i> |
| RG-284 | PI 348910 | Ambarby White           | Azerbaijan  | Pop 4/Aromatic                    | 6   | <i>Japonica</i> |
| RG-288 | PI 373900 | Besudi Long-Grain       | Afghanistan | Admixture                         | 22  | <i>Japonica</i> |
| RG-289 | PI 373901 | Besudi Short-Grain      | Afghanistan | Pop 2/Tropical <i>Japonica</i> -2 | 23  | <i>Japonica</i> |
| RG-305 | PI 431000 | Dera Wadi 1/43          | Afghanistan | Pop 1/Aus                         | 43  | <i>Indica</i>   |
| RG-310 | PI 431024 | Cat 1747                | Russia      | Pop 6/ <i>Indica</i>              | 26  | <i>Indica</i>   |
| RG-311 | PI 431031 | P 817                   | Russia      | Admixture                         | 108 | <i>Indica</i>   |
| RG-316 | PI 431195 | Vulgaris Ko Ch Azpasaly | Uzbekistan  | Pop 6/ <i>Indica</i>              | 156 | <i>Indica</i>   |
| RG-319 | PI 431201 | UZ ROS 59               | Uzbekistan  | Pop 6/ <i>Indica</i>              | 146 | <i>Indica</i>   |
| RG-332 | PI 431235 | P 1041                  | Russia      | Pop 6/ <i>Indica</i>              | 106 | <i>Indica</i>   |
| RG-334 | PI 431242 | P 1048                  | Russia      | Pop 4/Aromatic                    | 107 | <i>Japonica</i> |
| RG-336 | PI 431267 | HZ ROS 637              | Uzbekistan  | Pop 6/ <i>Indica</i>              | 69  | <i>Indica</i>   |
| RG-338 | PI 439621 | Azerbaidjanica          | Azerbaijan  | Pop 5/Temperate <i>Japonica</i>   | 15  | <i>Japonica</i> |
| RG-340 | PI 439624 | Kasakstanica            | Kazakhstan  | Pop 6/ <i>Indica</i>              | 80  | <i>Indica</i>   |
| RG-343 | PI 439629 | Nigrescens              | Russia      | Pop 5/Temperate <i>Japonica</i>   | 105 | <i>Japonica</i> |
| RG-346 | PI 439633 | Ak Tohum                | Azerbaijan  | Admixture                         | 3   | <i>Indica</i>   |
| RG-348 | PI 439637 | Dicolorata              | Azerbaijan  | Pop 4/Aromatic                    | 47  | <i>Japonica</i> |
| RG-354 | PI 439650 | Bak Saly Mestnyj        | Azerbaijan  | Admixture                         | 16  | <i>Japonica</i> |
| RG-355 | PI 439661 | DONSKOJ 2               | Russia      | Pop 5/Temperate <i>Japonica</i>   | 53  | <i>Japonica</i> |
| RG-357 | PI 439664 | Dv Ros 0219             | Russia      | Pop 5/Temperate <i>Japonica</i>   | 57  | <i>Japonica</i> |

|        |           |                      |             |                                 |     |                 |
|--------|-----------|----------------------|-------------|---------------------------------|-----|-----------------|
| RG-358 | PI 439665 | Dv Ros 2568          | Russia      | Pop 1/Aus                       | 58  | <i>Indica</i>   |
| RG-363 | PI 439677 | Kasaki Shala Mestnyj | Uzbekistan  | Pop 5/Temperate <i>Japonica</i> | 79  | <i>Japonica</i> |
| RG-364 | PI 439679 | Kesa                 | Azerbaijan  | Pop 6/ <i>Indica</i>            | 170 | <i>Indica</i>   |
| RG-365 | PI 439683 | KUBANETS 508         | Russia      | Pop 5/Temperate <i>Japonica</i> | 171 | <i>Japonica</i> |
| RG-371 | PI 439724 | Severnyj             | Russia      | Pop 5/Temperate <i>Japonica</i> | 172 | <i>Japonica</i> |
| RG-372 | PI 439730 | UZBEKSKIJ 2          | Uzbekistan  | Pop 5/Temperate <i>Japonica</i> | 148 | <i>Japonica</i> |
| RG-373 | PI 439733 | Uz Ros 421           | Uzbekistan  | Admixture                       | 150 | <i>Japonica</i> |
| RG-375 | PI 446913 | Pioner 320           | Uzbekistan  | Pop 5/Temperate <i>Japonica</i> | 112 | <i>Japonica</i> |
| RG-376 | PI 458444 | Krasnodarski         | Russia      | Pop 5/Temperate <i>Japonica</i> | 86  | <i>Japonica</i> |
| RG-379 | PI 584584 | LUK TAKHAR           | Afghanistan | Pop 1/Aus                       | 93  | <i>Indica</i>   |
| RG-380 | PI 584615 | WIR 623              | Uzbekistan  | Pop 5/Temperate <i>Japonica</i> | 166 | <i>Japonica</i> |
| RG-383 | PI 584618 | WIR 1528             | Azerbaijan  | Pop 5/Temperate <i>Japonica</i> | 163 | <i>Japonica</i> |
| RG-384 | PI 584620 | Hi Muke              | Kazakhstan  | Pop 1/Aus                       | 68  | <i>Indica</i>   |
| RG-385 | PI 584622 | WIR 2623             | Russia      | Pop 5/Temperate <i>Japonica</i> | 164 | <i>Japonica</i> |
| RG-389 | PI 584629 | Celiaj               | Azerbaijan  | Pop 5/Temperate <i>Japonica</i> | 28  | <i>Japonica</i> |
| RG-390 | PI 584633 | UZ ROS 2759          | Uzbekistan  | Pop 5/Temperate <i>Japonica</i> | 173 | <i>Japonica</i> |
| RG-393 | PI 584637 | KROS 358             | Kazakhstan  | Pop 5/Temperate <i>Japonica</i> | 87  | <i>Japonica</i> |
| RG-394 | PI 584640 | NF-1                 | Russia      | Pop 5/Temperate <i>Japonica</i> | 102 | <i>Japonica</i> |
| RG-395 | PI 584642 | NF-9                 | Russia      | Pop 5/Temperate <i>Japonica</i> | 103 | <i>Japonica</i> |
| RG-396 | PI 584644 | SPALCIK              | Russia      | Pop 5/Temperate <i>Japonica</i> | 134 | <i>Japonica</i> |
| RG-400 | PI 584649 | INTENSIVNYJ          | Uzbekistan  | Pop 6/ <i>Indica</i>            | 70  | <i>Indica</i>   |
| RG-403 | PI 584652 | ZEMCYZNYJ            | Russia      | Pop 5/Temperate <i>Japonica</i> | 167 | <i>Japonica</i> |
| RG-404 | PI 596813 | WIR 3419             | Azerbaijan  | Pop 4/Aromatic                  | 165 | <i>Japonica</i> |
| RG-412 | PI 61718  | Shala                | Turkistan   | Pop 6/ <i>Indica</i>            | 127 | <i>Indica</i>   |
| RG-413 | PI 65884  | Styk                 | Azerbaijan  | Pop 4/Aromatic                  | 137 | <i>Japonica</i> |

|        |           |                      |               |                           |     |                 |
|--------|-----------|----------------------|---------------|---------------------------|-----|-----------------|
| RG-550 | PI 636839 | WAB450-11-1-3-P40-HB | Cote D'Ivoire | Pop 2/Tropical Japonica-2 | 157 | <i>Japonica</i> |
| RG-551 | PI 636840 | WAB450-24-2-3-P33-HB | Cote D'Ivoire | Pop 2/Tropical Japonica-2 | 158 | <i>Japonica</i> |
| RG-552 | PI 636841 | WAB450-24-3-P38-1-HB | Cote D'Ivoire | Admixture                 | 159 | Admixture       |
| RG-557 | PI 636846 | WAB450-I-B-P-38-HB   | Cote D'Ivoire | Admixture                 | 160 | <i>Japonica</i> |
| RG-558 | PI 636847 | WAB450-I-B-P-62-HB   | NA            | Admixture                 | 161 | <i>Japonica</i> |
| RG-575 | PI 636465 | Presidio             | US            | Pop 3/Tropical Japonica-1 | 113 | <i>Japonica</i> |
| RG-578 | PI 385751 | Kharsu               | Pakistan      | Pop 1/Aus                 | 83  | <i>Indica</i>   |
| U-117  | NA        | JAZZMAN 2            | US            | Pop 3/Tropical Japonica-1 | 73  | <i>Japonica</i> |
| U-118  | NA        | CL 172               | US            | Pop 3/Tropical Japonica-1 | 36  | <i>Japonica</i> |
| U-119  | NA        | M206                 | US            | Admixture                 | 95  | <i>Japonica</i> |
| U-120  | NA        | CL 163               | US            | Pop 3/Tropical Japonica-1 | 35  | <i>Japonica</i> |
| U-158  | NA        | DELLA 2              | US            | Pop 3/Tropical Japonica-1 | 42  | <i>Japonica</i> |
| U-159  | NA        | ANTONIO              | US            | Pop 3/Tropical Japonica-1 | 8   | <i>Japonica</i> |
| U-160  | NA        | THAD                 | US            | Pop 3/Tropical Japonica-1 | 141 | <i>Japonica</i> |
| U-17   | NA        | CL 111               | US            | Pop 3/Tropical Japonica-1 | 32  | <i>Japonica</i> |
| U-18   | NA        | CL 153               | US            | Pop 3/Tropical Japonica-1 | 34  | <i>Japonica</i> |
| U-199  | NA        | RONDO                | US            | Pop 6/ <i>Indica</i>      | 119 | <i>Indica</i>   |
| U-20   | NA        | MERMENTAU            | US            | Pop 3/Tropical Japonica-1 | 97  | <i>Japonica</i> |
| U-200  | NA        | CL 151               | US            | Pop 3/Tropical Japonica-1 | 33  | <i>Japonica</i> |
| U-37   | NA        | JUPITER              | US            | Admixture                 | 76  | <i>Japonica</i> |
| U-38   | NA        | WELLS                | US            | Pop 3/Tropical Japonica-1 | 162 | <i>Japonica</i> |
| U-39   | NA        | LAKAST               | US            | Pop 3/Tropical Japonica-1 | 90  | <i>Japonica</i> |
| U-40   | NA        | DIAMOND              | US            | Pop 3/Tropical Japonica-1 | 46  | <i>Japonica</i> |
| U-56   | NA        | MM-14                | US            | Admixture                 | 98  | <i>Japonica</i> |
| U-57   | NA        | REX                  | US            | Admixture                 | 118 | <i>Japonica</i> |

|      |    |          |    |                                   |     |                 |
|------|----|----------|----|-----------------------------------|-----|-----------------|
| U-58 | NA | CHENIERE | US | Pop 3/Tropical <i>Japonica</i> -1 | 31  | <i>Japonica</i> |
| U-59 | NA | COCODRIE | US | Pop 3/Tropical <i>Japonica</i> -1 | 38  | <i>Japonica</i> |
| U-60 | NA | CL272    | US | Admixture                         | 37  | <i>Japonica</i> |
| U-79 | NA | ROY J    | US | Pop 3/Tropical <i>Japonica</i> -1 | 120 | <i>Japonica</i> |
| U-80 | NA | TITAN    | US | Admixture                         | 143 | <i>Japonica</i> |

a= STRUCTURE software assigned serial number, called “Unit”, to each sample used in this study. These numbers were displayed in Figure 1(B); b= Based on cluster analysis (Figure 2), subpopulations with close genetic distance were grouped either into “*Indica*” or “*Japonica*” subpopulation, two major subpopulations in rice. These two major groups had been used for phenotypic analysis, *In-Silico* Gene Expression analysis, and Gene enrichment analysis.



**Table S2.** Phenotypic variation in the whole panel and *Indica* and *Japonica* sub-groups.

| Traits | Whole Panel |        |        |         |       |                             |         | Indica  |        | Japonica |        |
|--------|-------------|--------|--------|---------|-------|-----------------------------|---------|---------|--------|----------|--------|
|        | Mean        | SD     | Min    | Max     | CV    | R <sup>2</sup> <sup>a</sup> | P-value | Mean    | SD     | Mean     | SD     |
| Cu     | 2.99        | 0.66   | 1.33   | 6.63    | 22.06 | 0.02                        | 0.04    | 2.91*   | 0.70   | 3.06     | 0.62   |
| Fe     | 17.21       | 3.45   | 6.37   | 30.77   | 20.04 | 0.10                        | 0.00    | 16.71*  | 3.43   | 17.64    | 3.42   |
| K      | 2492.84     | 422.67 | 793.67 | 4788.57 | 16.96 | 0.01                        | 0.34    | 2471.84 | 425.71 | 2510.32  | 420.47 |
| Mg     | 1419.99     | 253.32 | 435.10 | 2585.49 | 17.84 | 0.01                        | 0.11    | 1434.59 | 250.75 | 1407.83  | 255.47 |
| Mn     | 21.78       | 5.38   | 6.85   | 48.99   | 24.71 | 0.02                        | 0.02    | 20.88*  | 5.04   | 22.54    | 5.55   |
| Zn     | 26.53       | 8.77   | 4.75   | 52.64   | 33.05 | 0.04                        | 0.00    | 27.96*  | 6.81   | 25.34    | 9.98   |

\* indicates that mean mineral concentration of *Indica* and *Japonica* subpopulation was significantly different from each other at  $\alpha=0.05$  level.

<sup>a</sup>= R<sup>2</sup> indicates how much variation of mineral element concentration is explained by population structure in one-way ANOVA model.

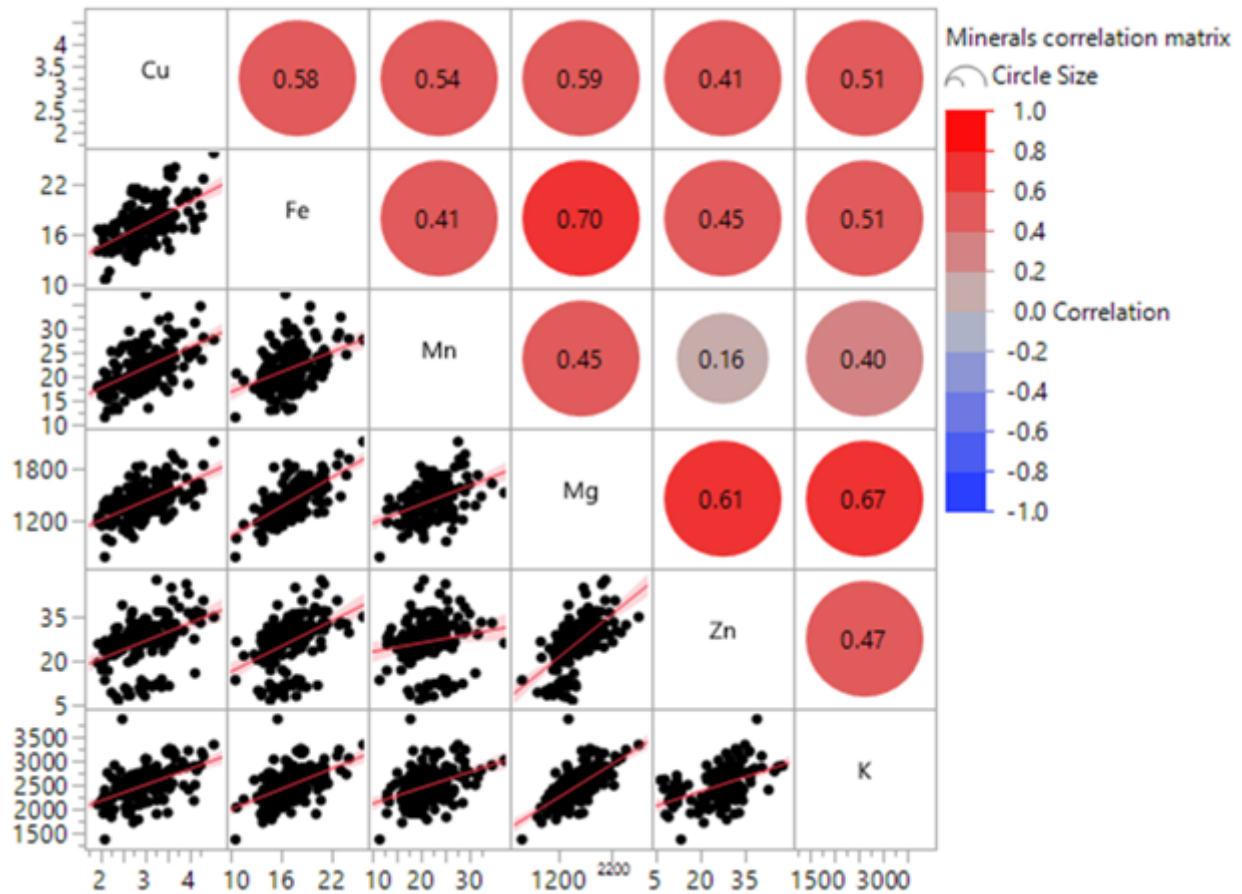
**Table S3.** Comparison of the GWAS result with the previous studies.

| Trait | SNP                 | Position (bp) | Chr | Markers linked/ associated  | Position (bp)   | Types of Markers | Known genes | References                                    |
|-------|---------------------|---------------|-----|---|---|------------------|-------------|---|
| Cu    | SNP-1.13478728.     | 13479755      | 1   | ud1000606   | 13429671  | SNP              |             | Norton et al. (2014)                          |
|       | 6147112             | 10199497      | 6   | id6006288   | 10090472  | SNP              |             | Norton et al. (2014)                          |
|       | id7001155**         | 6987625       | 7   | RM214   | 5Mb - 20Mb  | SSR              |             | Zhang et al. (2014)                           |
|       | id8006885           | 24881549      | 8   | RM3155, id8007452   | 23Mb – 28Mb, 27210520   | SSR, SNP         |             | Zhang et al. (2014), Norton et al. (2014)     |
|       | SNP-11.25392640. ** | 25858722      | 11  | id11010366, id11010372, id11010373  | 25850373, 25851231, 25851251  | SNP              |             | Norton et al. (2014)                          |
| Fe    | 153297              | 4823701       | 1   | RM283   | 4886944 - 4886983   | SSR              |             | Nawaz et al. (2015)                           |
|       | SNP-1.32376151.     | 32377196      | 1   | RM5   | 23Mb - 35Mb   | SSR              |             | Zhang et al. (2014)                           |
|       | SNP-2.8455563.      | 8455565       | 2   | RG437, RM452, RM145/Os02ssr0079000  | 7Mb – 1Mb0, 7706972 - 7707033   | RFLP, SSR, SSR   |             | Zhang et al. (2014), Nawaz et al. (2015)      |
|       | 2267750             | 27548893      | 2   | RM6933  | 24Mb - 31Mb   | SSR              |             | Zhang et al. (2014)                           |
|       | 3501392             | 33987612      | 3   | RM514, AX-95935621, AX-95950999, AX-95935460, AX-95924055, AX-95923317, AX-95923159 | 29Mb – 36Mb, 32326592, 32335075, 32374286, 32380341, 32380432, 32380964 | SSR, SNP         |             | Zhang et al. (2014), Bollinedi et al. (2020), |
|       | 4241771             | 16199670      | 4   | RM3317, RM471   | 5Mb – 20Mb, 18996850 - 18996873   | SSR, SSR         |             | Zhang et al. (2014), Nawaz et al. (2015)      |
|       | SNP-4.6317262.      | 6321823       | 4   | RM3317  | 5Mb - 20Mb  | SSR              |             | Zhang et al. (2014)                           |
|       | SNP-4.10930754.     | 10940054      | 4   | RM3317  | 5Mb - 20Mb  | SSR              |             | Zhang et al. (2014)                           |
|       | 4128471             | 12879859      | 4   | RM3317  | 5Mb - 20Mb  | SSR              |             | Zhang et al. (2014)                           |
|       | SNP-4.13348501.     | 13357791      | 4   | RM3317  | 5Mb - 20Mb  | SSR              |             | Zhang et al. (2014)                           |
|       | 4882140             | 2378143       | 5   | RM13  | 0 - 5500000   | SSR              |             | Zhang et al. (2014)                           |

|    |                    |          |    |  |                                  |           |        |   |
|----|--------------------|----------|----|--|----------------------------------|-----------|--------|---|
|    | SNP-6.1343132.     | 1344132  | 6  | RM190, RM190                                       | 0 – 4Mb, 1765669 - 1765704       | SSR, SSR  |        | Zhang et al. (2014), Nawaz et al.(2015)           |
|    | SNP-6.2196821.     | 2197821  | 6  | RM190  | 0 - 4Mb                          | SSR       |        | Zhang et al. (2014)                               |
|    | SNP-7.29385457.    | 29386450 | 7  | RM248, RM1335                                      | 26Mb – 30Mb, 28299722 - 28299763 | SSR, SSR  | OsNAS3 | Zhang et al. (2014), Nawaz et al.(2015)           |
|    | 9921984**          | 650031   | 10 | RM222  | 0 - 12Mb                         | SSR       |        | Zhang et al. (2014)                               |
|    | SNP-10.20587837.   | 20659359 | 10 | RM1108   | 18Mb - 21Mb                      | SSR       |        | Zhang et al. (2014)                               |
|    | 10778744           | 21397933 | 10 | RM1108   | 18Mb - 21Mb                      | SSR       |        | Zhang et al. (2014)                               |
| K  | SNP-1.6382810. **  | 6383811  | 1  | RG532a, RM1  | 3Mb - 7Mb                        | RFLP, SSR |        | Zhang et al. (2014)                               |
|    | SNP-1.23170758. ** | 23171803 | 1  | CDO455, RM5501, RM5                                | 23Mb – 35Mb, 23972466 - 23972495 | RFLP, SSR |        | Zhang et al. (2014), Garcia-Oliveira et al (2009) |
|    | 2375486**          | 31547627 | 2  | RM3732-RM492                                       | 7290000 - 44080000               | SSR       |        | Du et al. (2013)                                  |
|    | 2964807            | 17453008 | 3  | RM282-<br>RM6266/Os03ssr0099800-<br>Os03ssr0183400 | 12408722 - 23823856              | SSR       |        | Du et al. (2013)                                  |
|    | 3173191            | 22657915 | 3  | RM282-<br>RM6266/Os03ssr0099800-<br>Os03ssr0183400 | 12408722 - 23823856              | SSR       |        | Du et al. (2013)                                  |
|    | SNP-5.28500625. ** | 28563271 | 5  | RM188  | 21Mb - 27Mb                      | SSR       |        | Zhang et al. (2014)                               |
|    | 7892688**          | 26282546 | 7  | RM248, RM505/RM21926                               | 26Mb – 30Mb, 24527811 - 24527834 | SSR       |        | Zhang et al. (2014), Nawaz et al.(2015)           |
| Mg | 4882140            | 2378143  | 5  | RM13   | 0 - 5500000                      | SSR       |        | Zhang et al. (2014)                               |
|    | id5002528          | 4819475  | 5  | RM13   | 0 - 5500000                      | SSR       |        | Zhang et al. (2014)                               |
|    | 6285634            | 13487635 | 6  | RM527-RM3  | 9862309 - 28130383               | SSR       |        | Du et al. (2013)                                  |
|    | 6351040            | 14937819 | 6  | RM527-RM3  | 9862309 - 28130383               | SSR       |        | Du et al. (2013)                                  |
|    | 6496457**          | 17969922 | 6  | RM527-RM3  | 9862309 - 28130383               | SSR       |        | Du et al. (2013)                                  |
|    | SNP-10.20587837.   | 20659359 | 10 | RM5494   | 18Mb - 21Mb                      | SSR       |        | Zhang et al. (2014)                               |

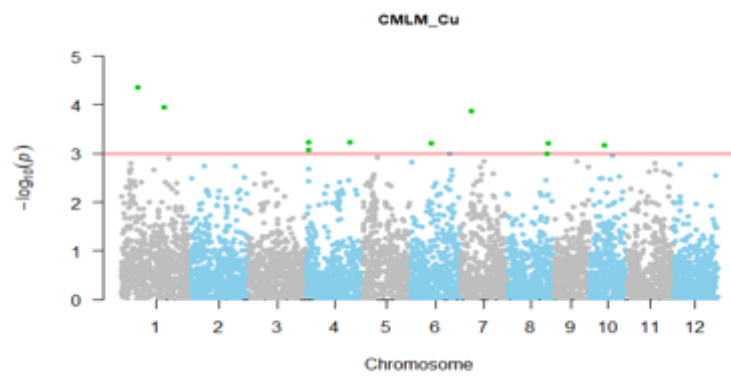
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|----|--------------------|----------|----|--|--|-----------|--------|--|
|    | SNP-11.235195.     | 236194   | 11 | RM5494   | 18Mb - 21Mb  | SSR       |        | Zhang et al. (2014)  |
|    | 10943015**         | 4419880  | 11 | RZ781, RM332   | 0 - 5Mb  | RFLP, SSR |        | Zhang et al. (2014)  |
| Mn | SNP-6.22337184. ** | 22338182 | 6  | RM527-RM3  | 9862309 - 28130383   | SSR       |        | Du et al. (2013)   |
| Zn | 1305247**          | 41042727 | 1  | AX-95918225  | 41121295   | SNP       | OsIRO2 | Bollinedi et al. (2020)  |
|    | SNP-3.28426789.    | 28433737 | 3  | id3013232  | 28309539   | SNP       |        | Norton et al. (2014)   |
|    | id4010220**        | 30330971 | 4  | RM317, id4010984, wd4003179, id4011016, id4011022, AX-95951158, RM317/Os04ssr0174300 | 28Mb – 33Mb, 31853012, 31953475, 31953961, 31957137, 32811874, 29246223 - 29246242 | SSR, SNP  | ZIP3   | Zhang et al. (2014), Norton et al. (2014), Bollinedi et al. (2020), Huang et al.(2015) |
|    | 10430775**         | 11051662 | 10 | RM222, id10003681, AX-95932094   | 0 – 12Mb, 13867606, 12685215   | SSR, SNP  |        | Zhang et al. (2014), Norton et al. (2014), Bollinedi et al. (2020)                     |

\*\* indicates the significant SNPs identified at 15% FDR.

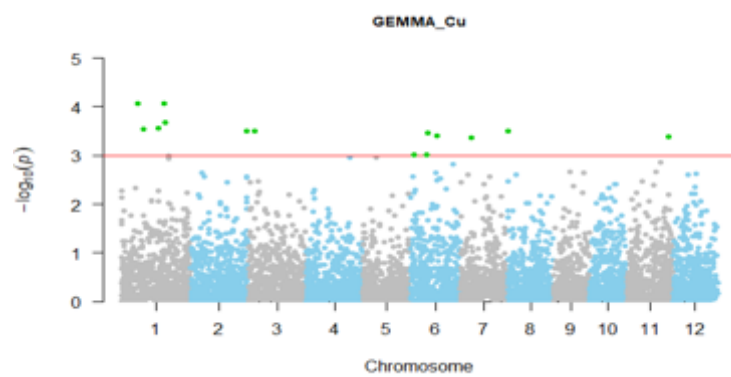
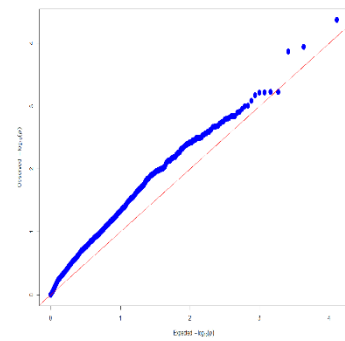


**Figure S1.** Correlation matrix for the six mineral elements. The value inside the circles shows correlation value between two minerals. Size of the circle indicate the magnitude of significant level at  $\alpha=0.05$ .

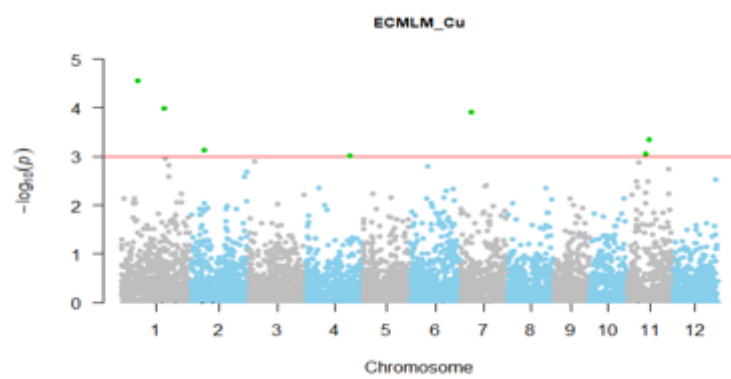
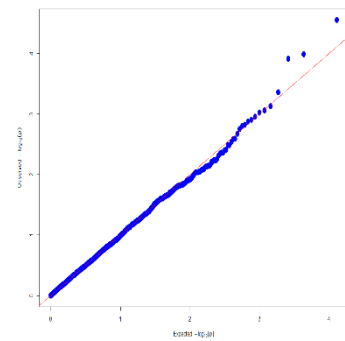
(A)



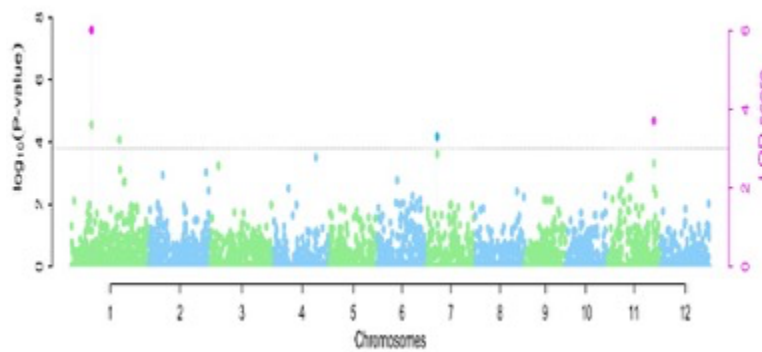
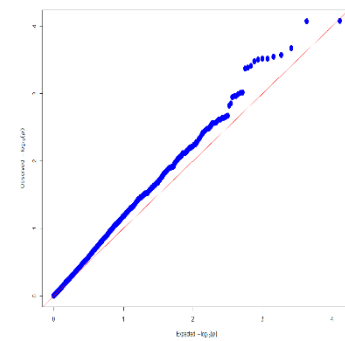
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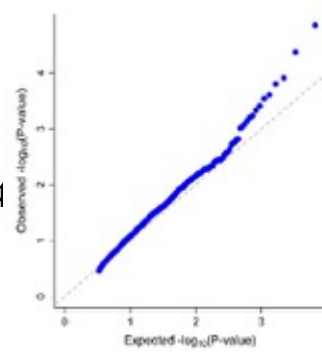
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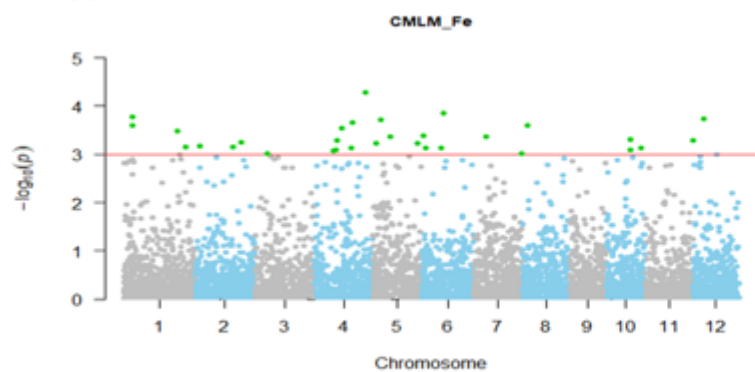
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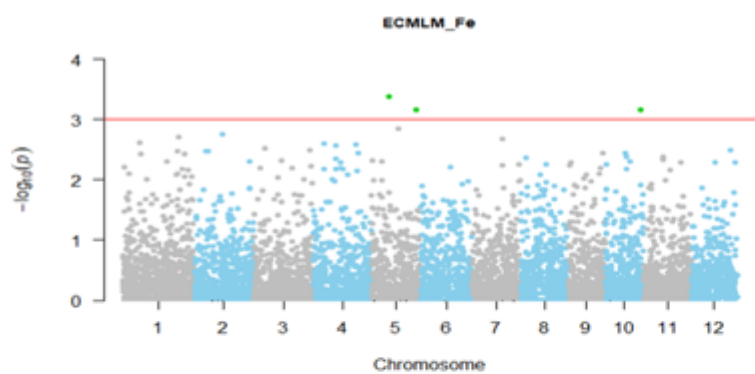
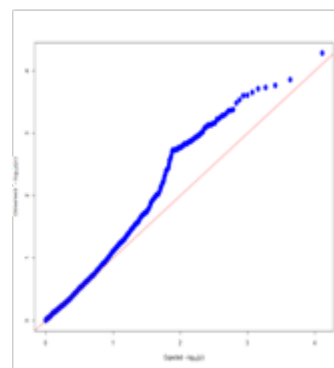
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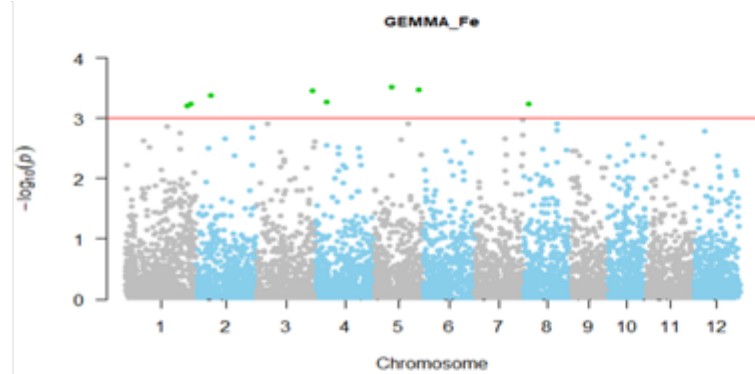
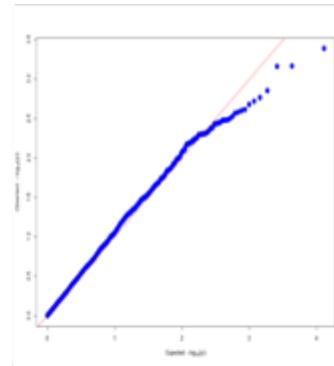
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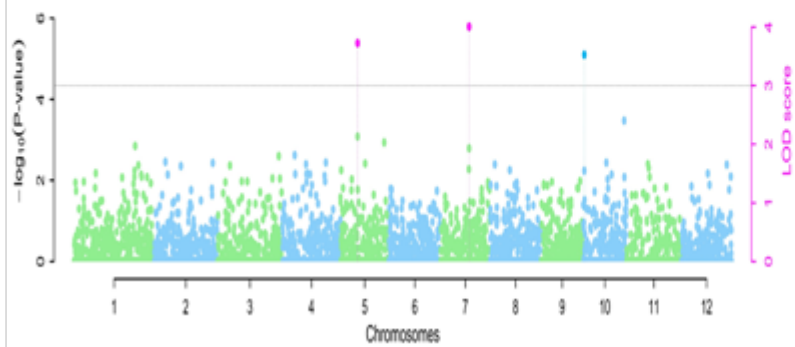
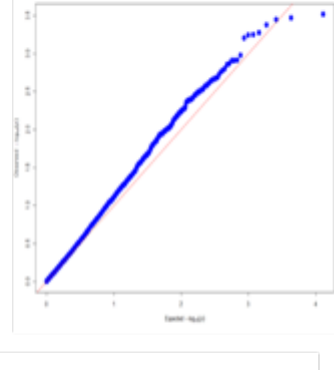
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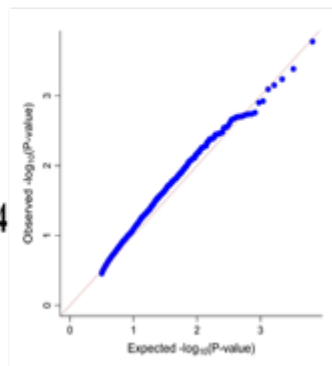
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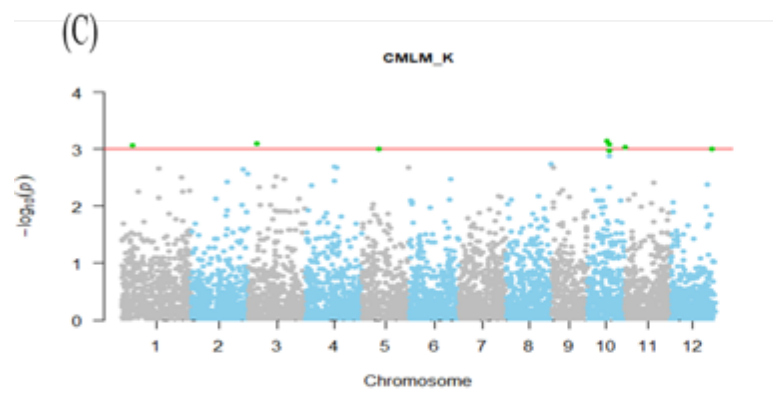


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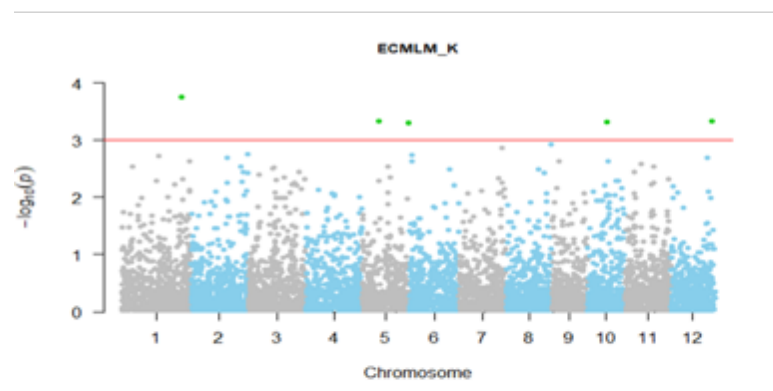
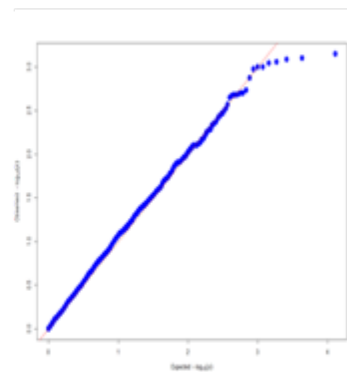


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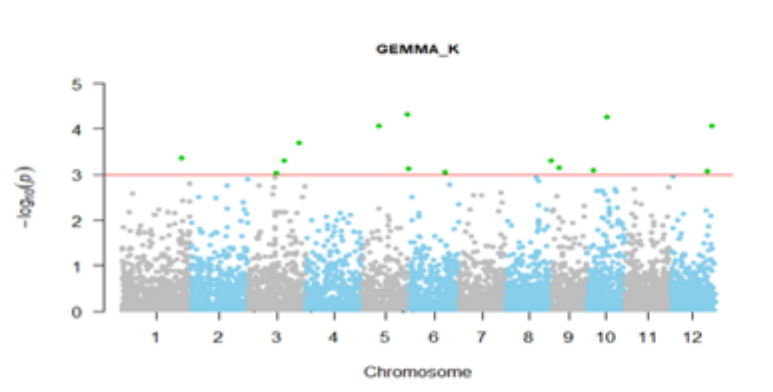
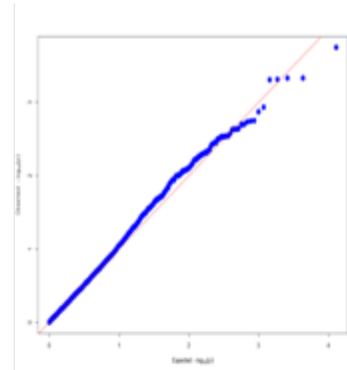




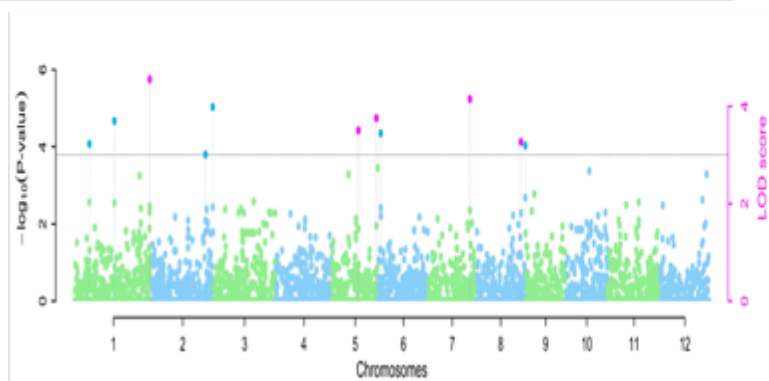
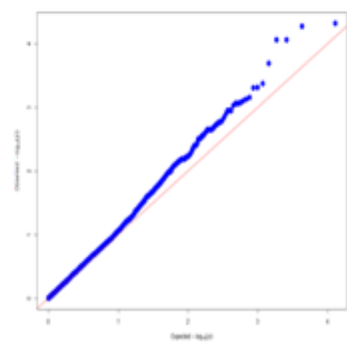
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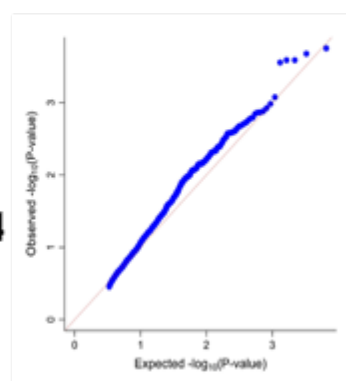
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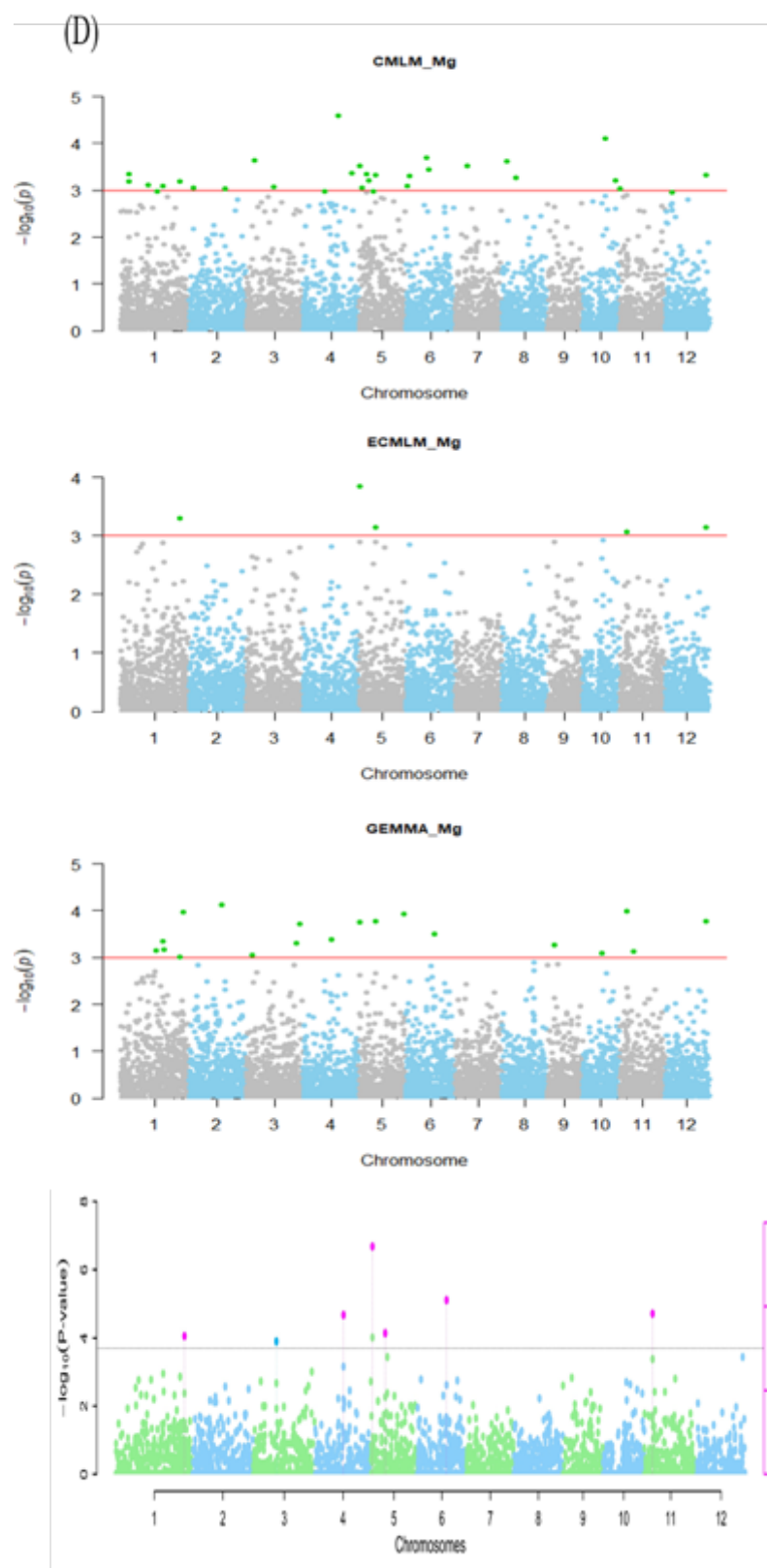
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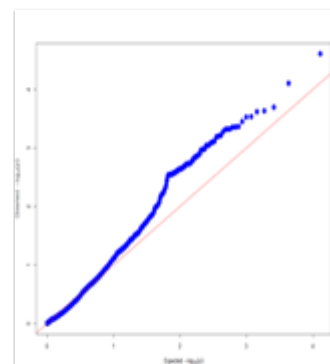
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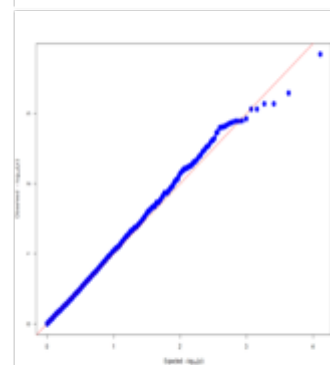




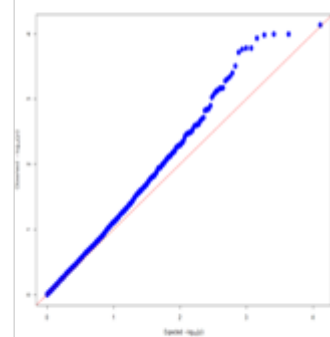
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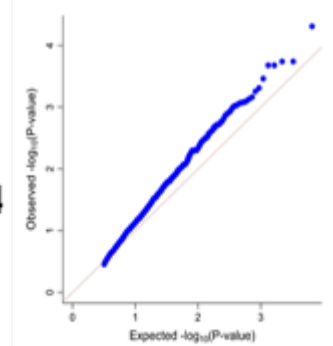
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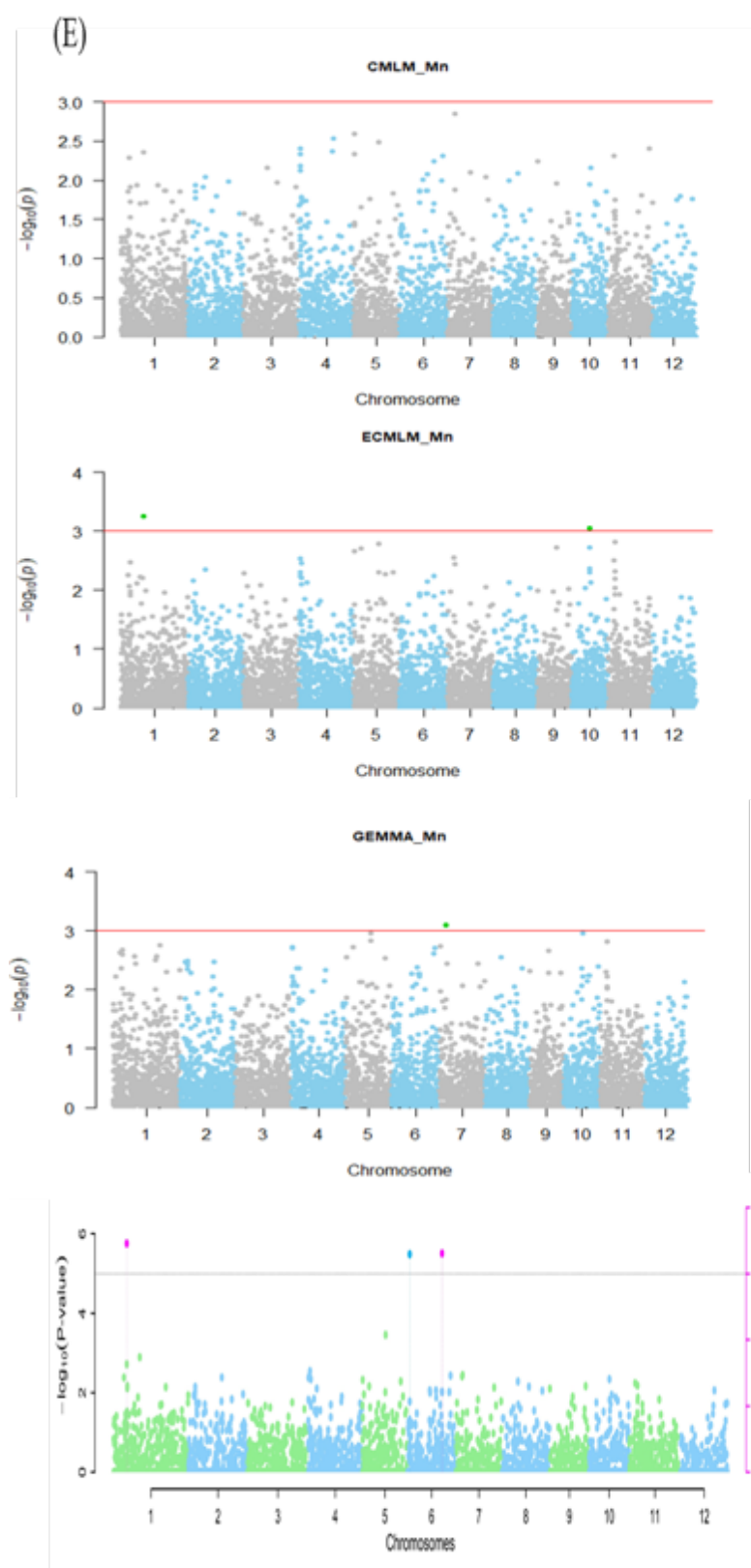


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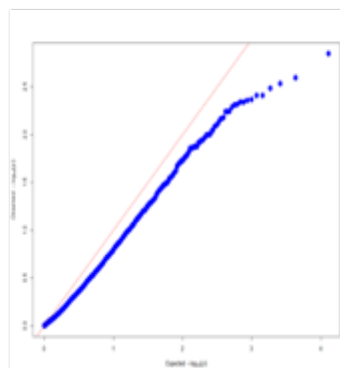


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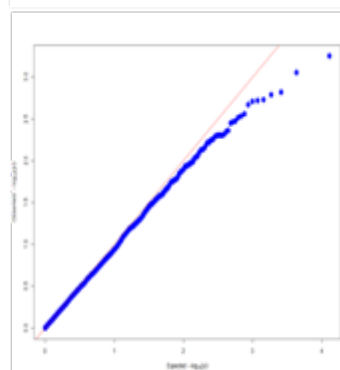




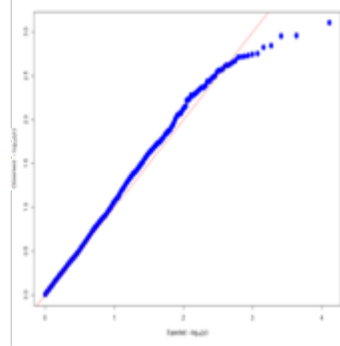
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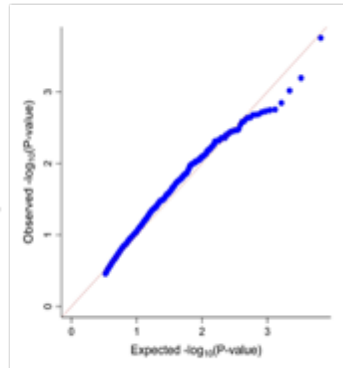
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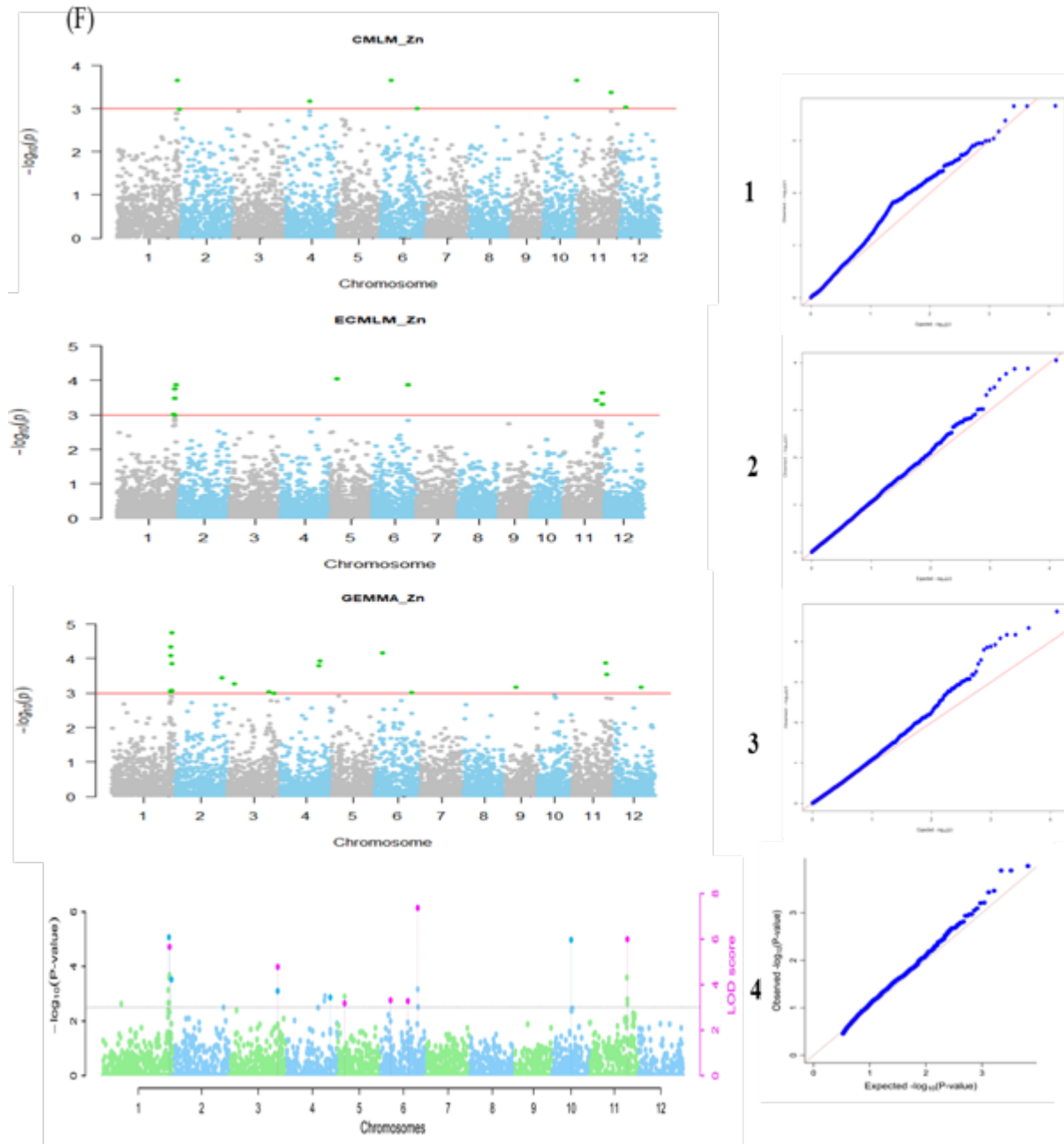


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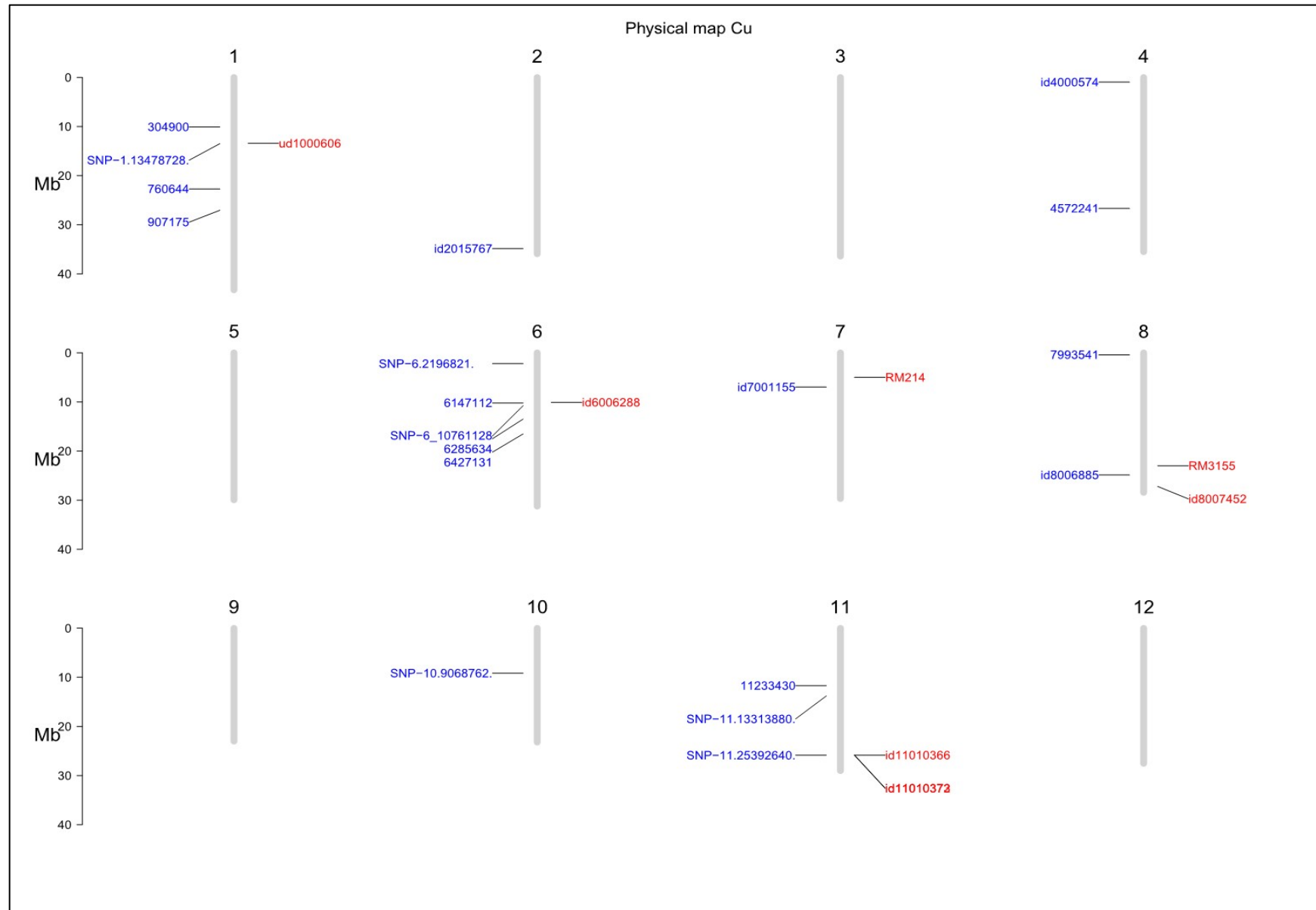
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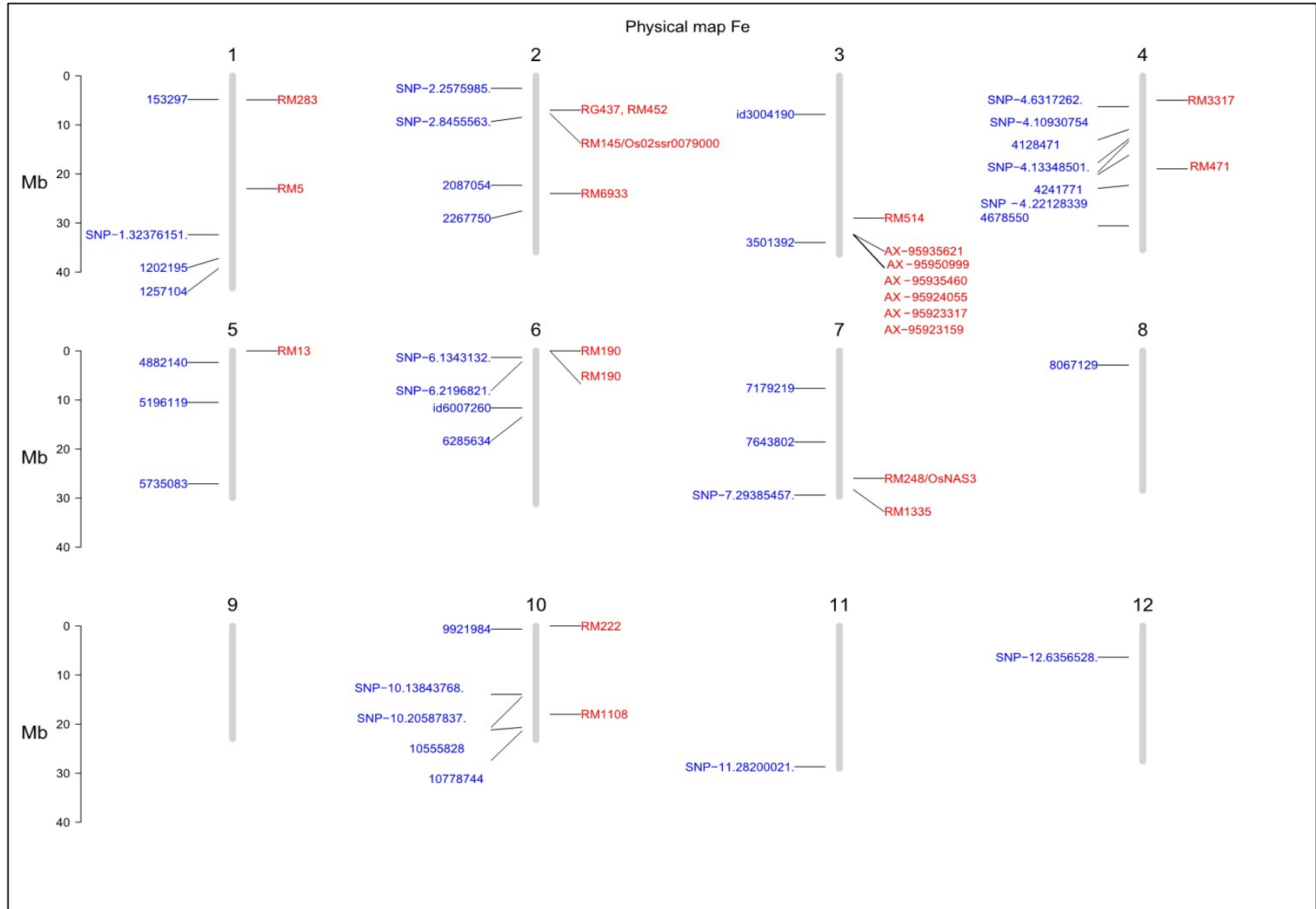


**Figure S2.** Manhattan plots of GWAS for six minerals. (1). Manhattan plot CMLM model. (2). Manhattan plot for ECMLM model. (3). Manhattan plot for GEMMA model. (4). Manhattan plot for multi-locus models, including mrMLM, FASTmrMLM, FASTmrEMMA, pLARmEB, pKWmEB, ISIS EM-BLASSO. The red horizontal line in the 1, 2, and 3 models is the threshold significant level used in the study to declare a SNP as being significant for measured traits. The green circles above the red line depict the significant SNPs. For 4 model, purple circles above the dashed horizontal line are the significant SNPs identified by any two models of six models, whereas green circles show only those SNPs identified by only one model of six models of multi-locus method. (A) Cu. (B) Fe, (C) K. (D) Mg. (E) Mn. (F) Zn.

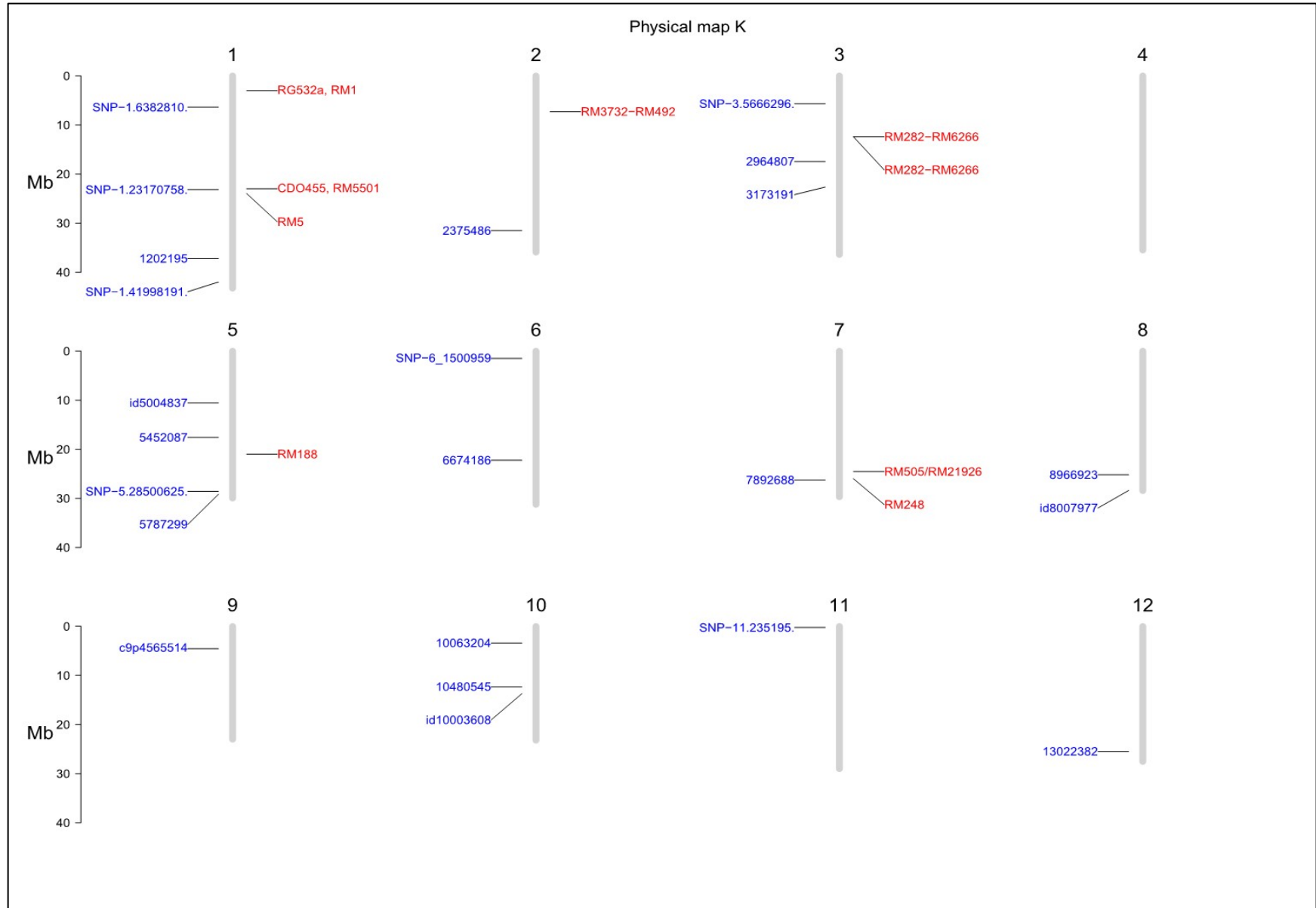
# 1. Cu



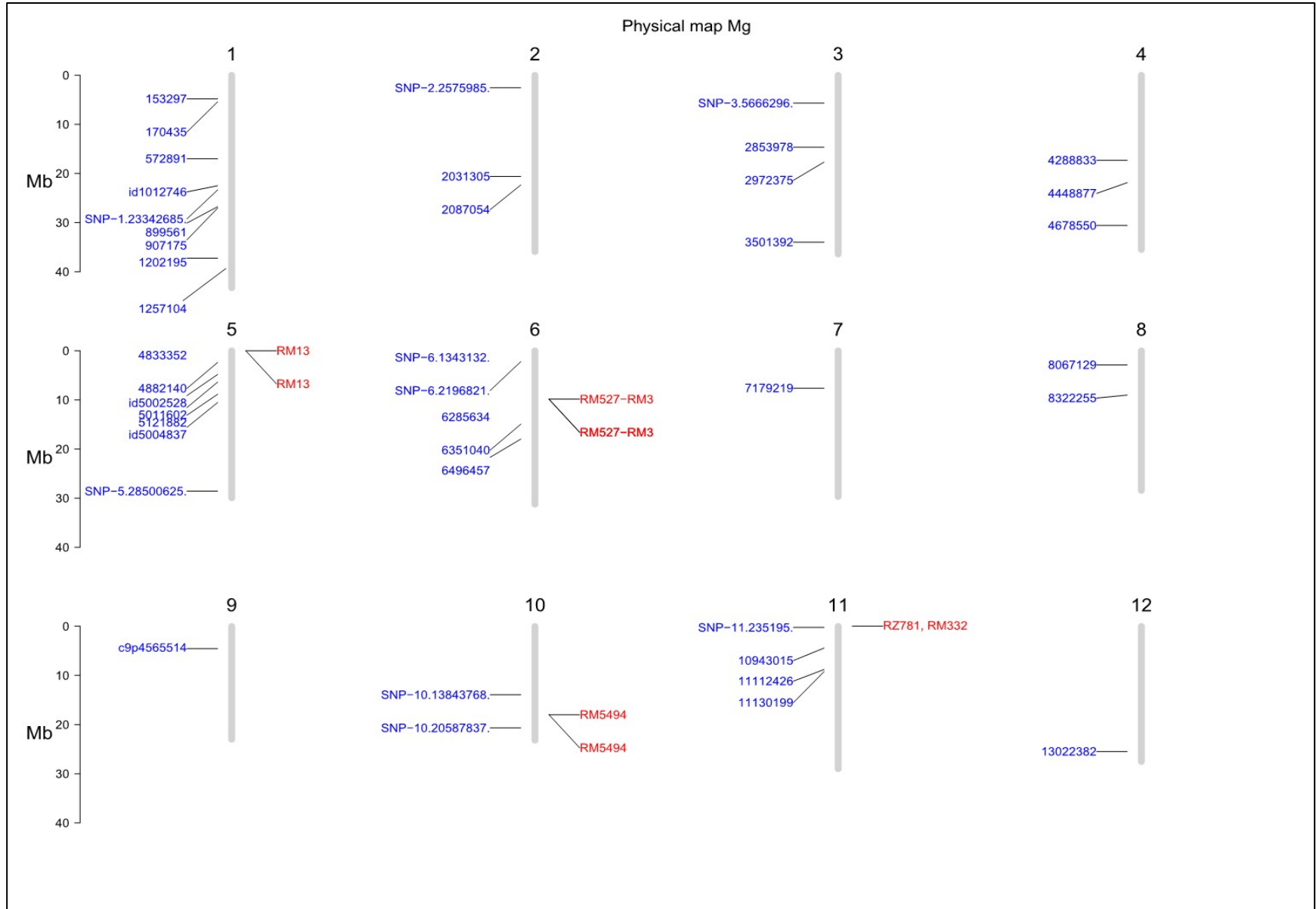
## 2. Fe



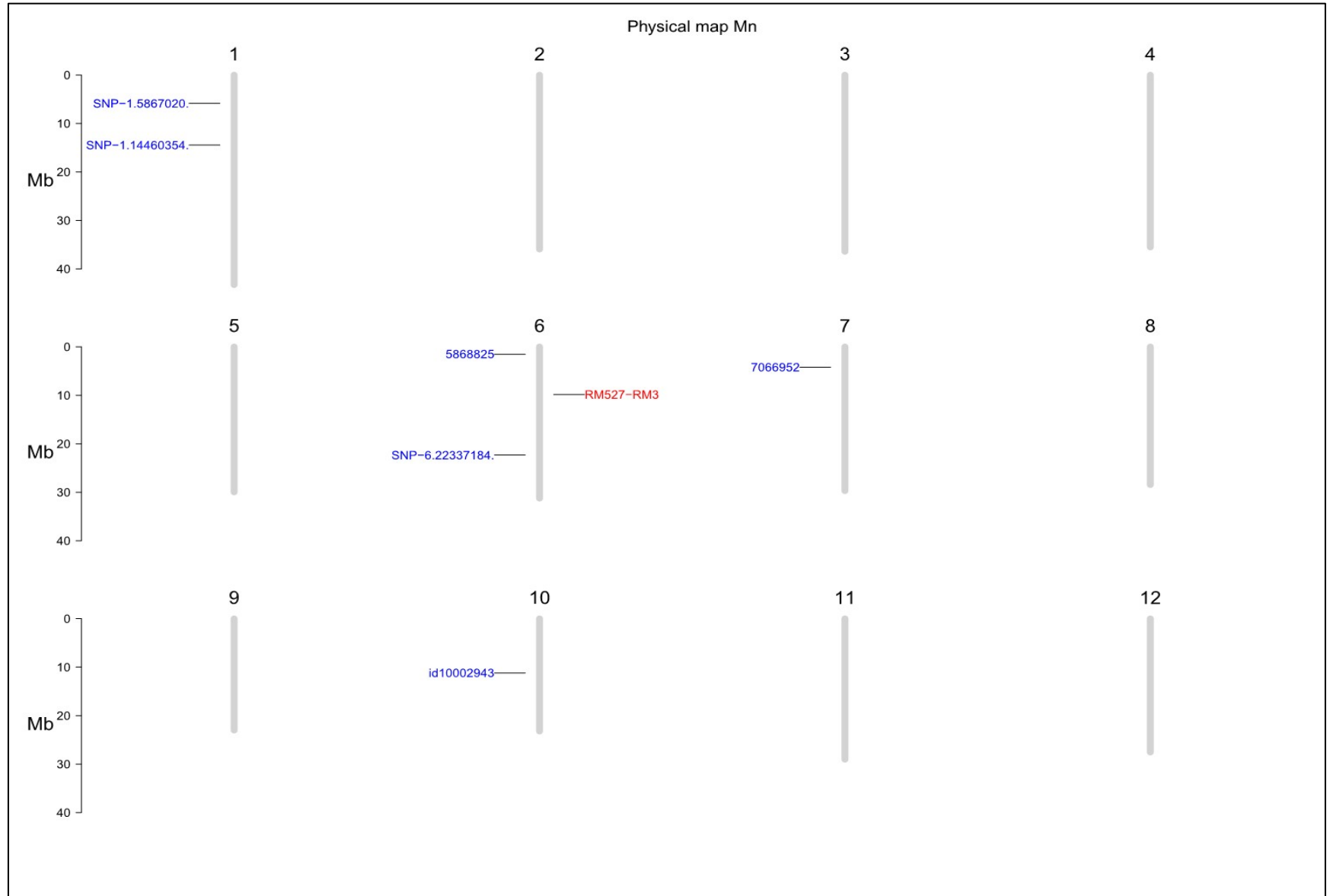
### 3. K



#### 4. Mg

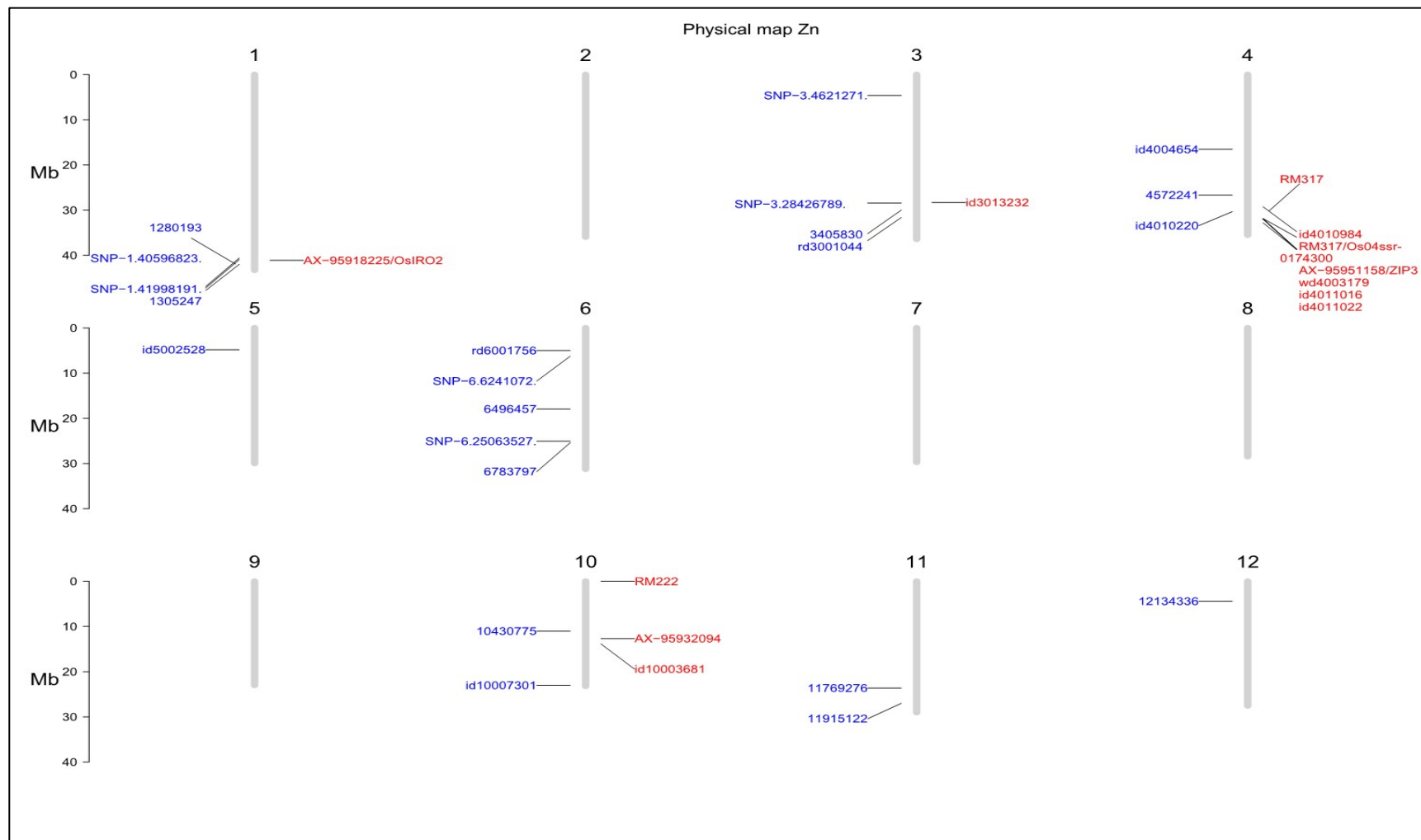


## 5. Mn

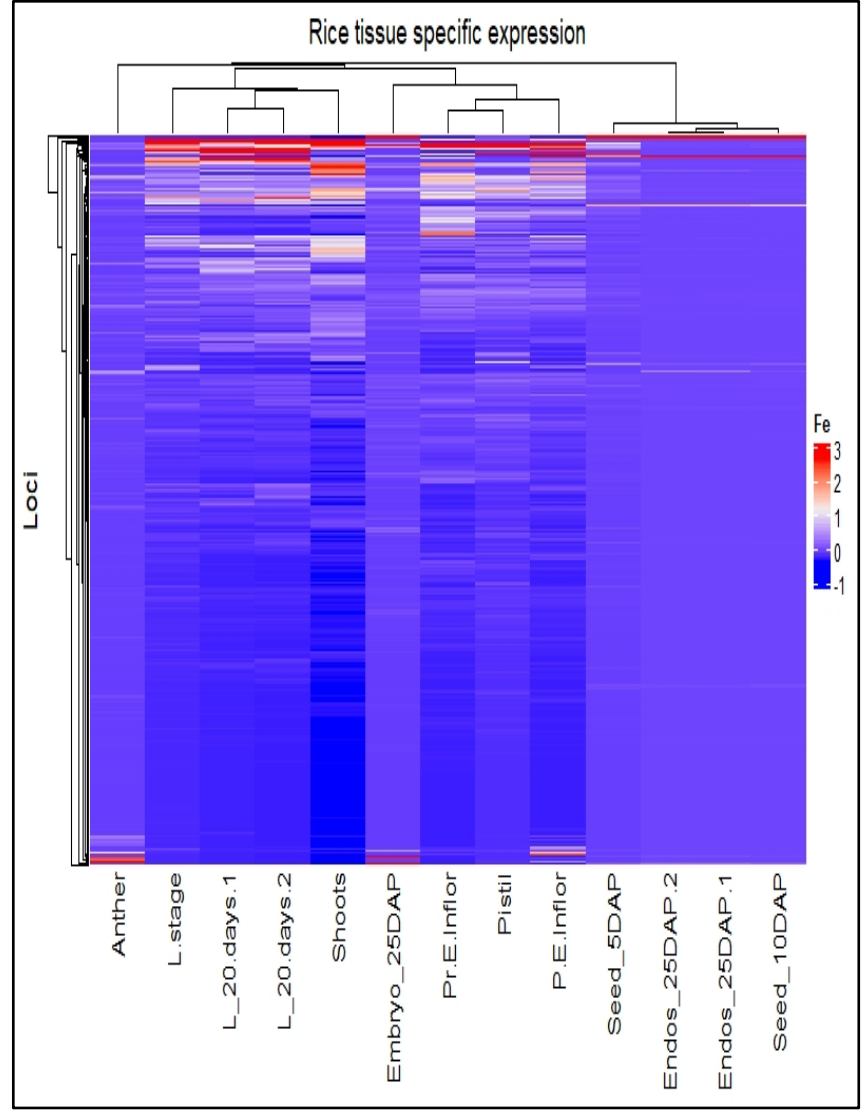
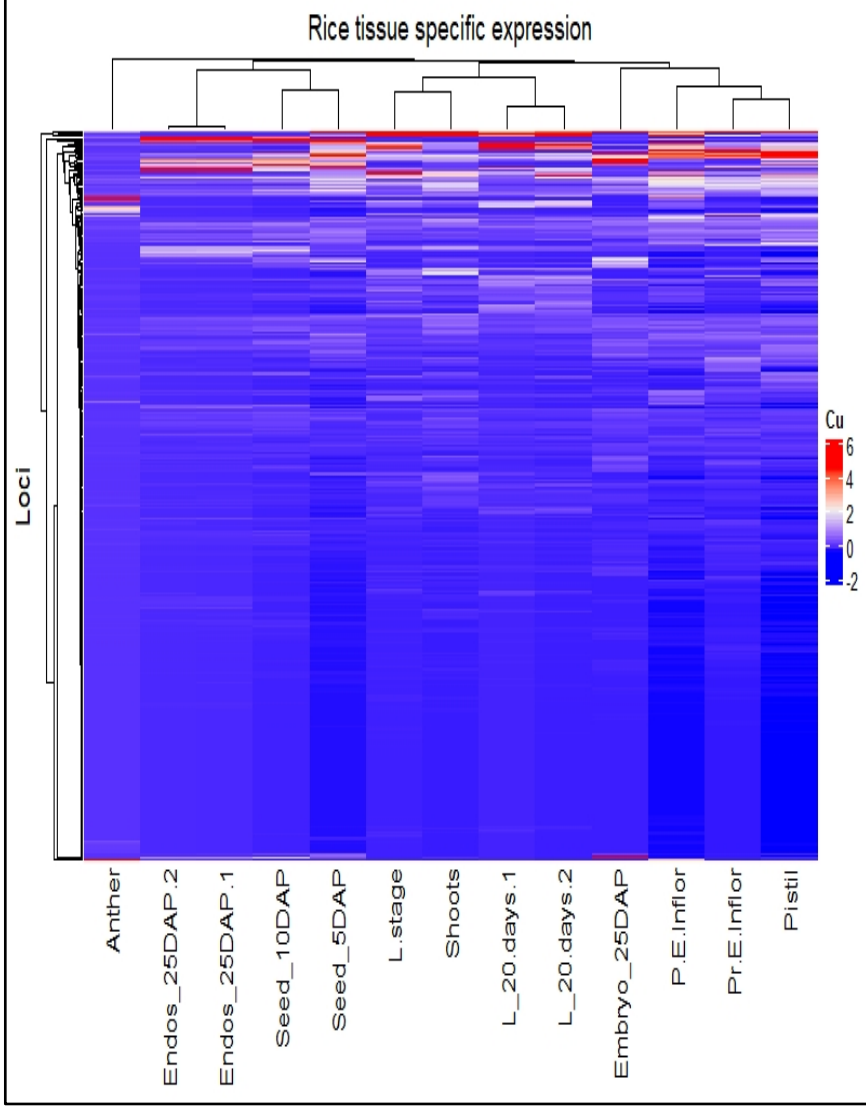


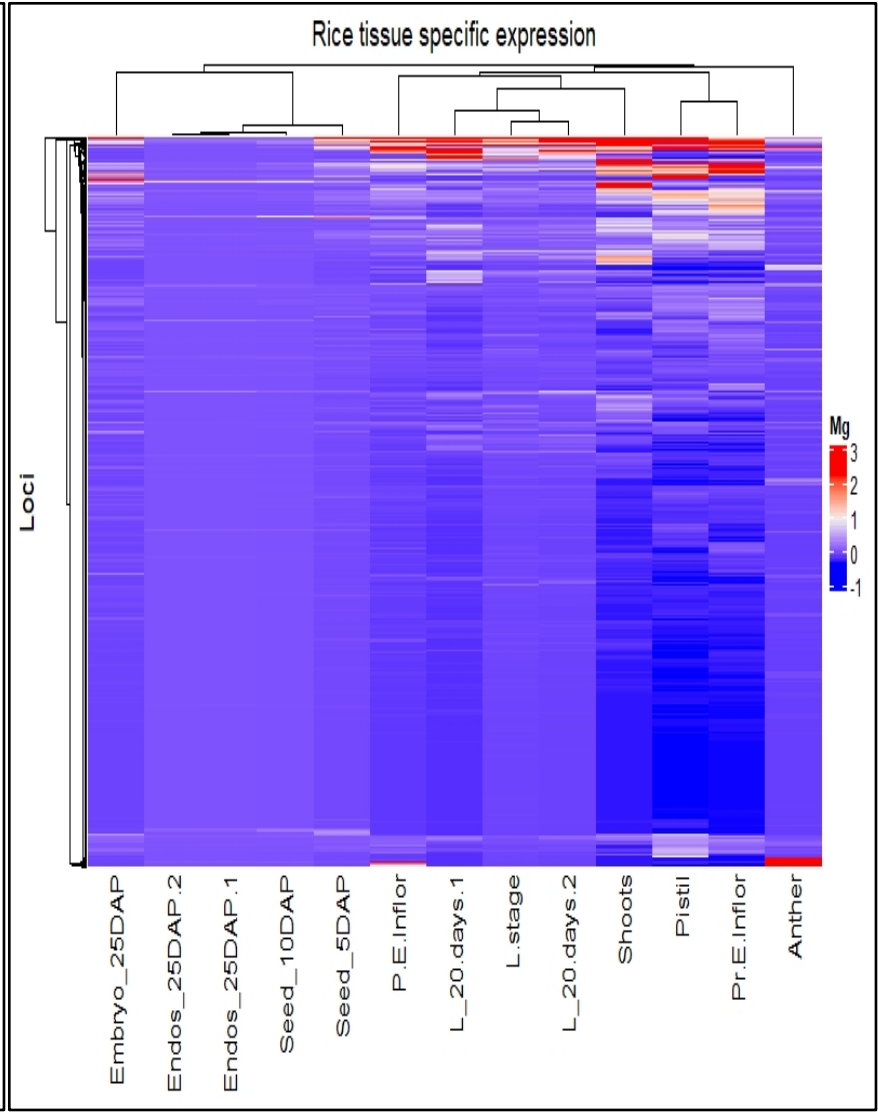
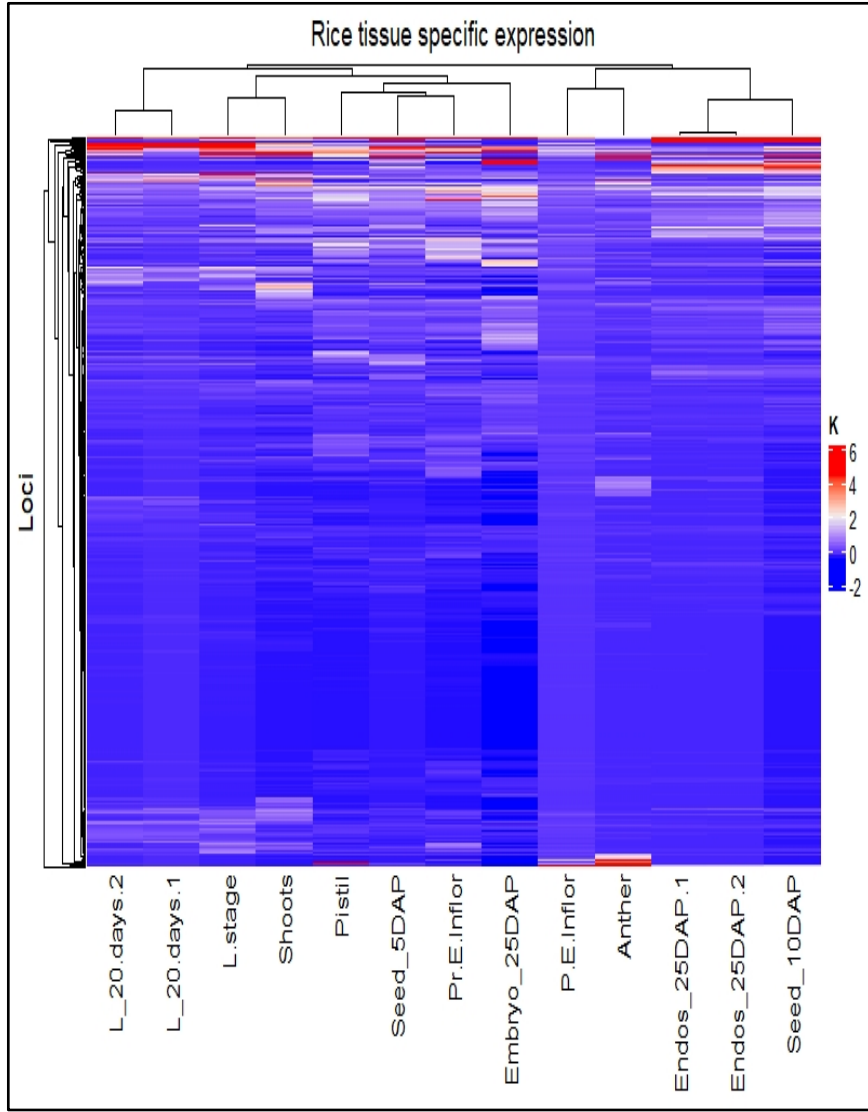


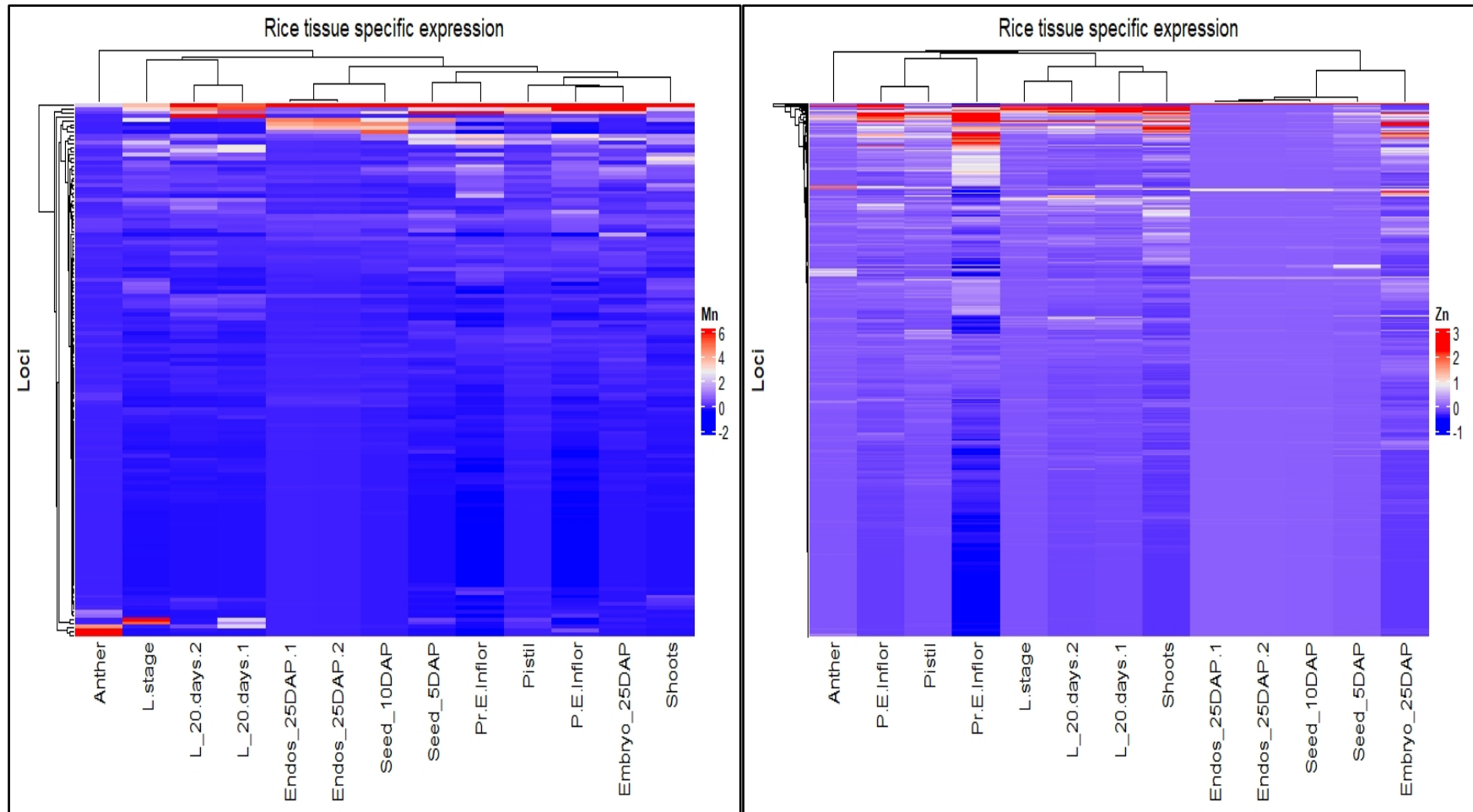
## 6. Zn



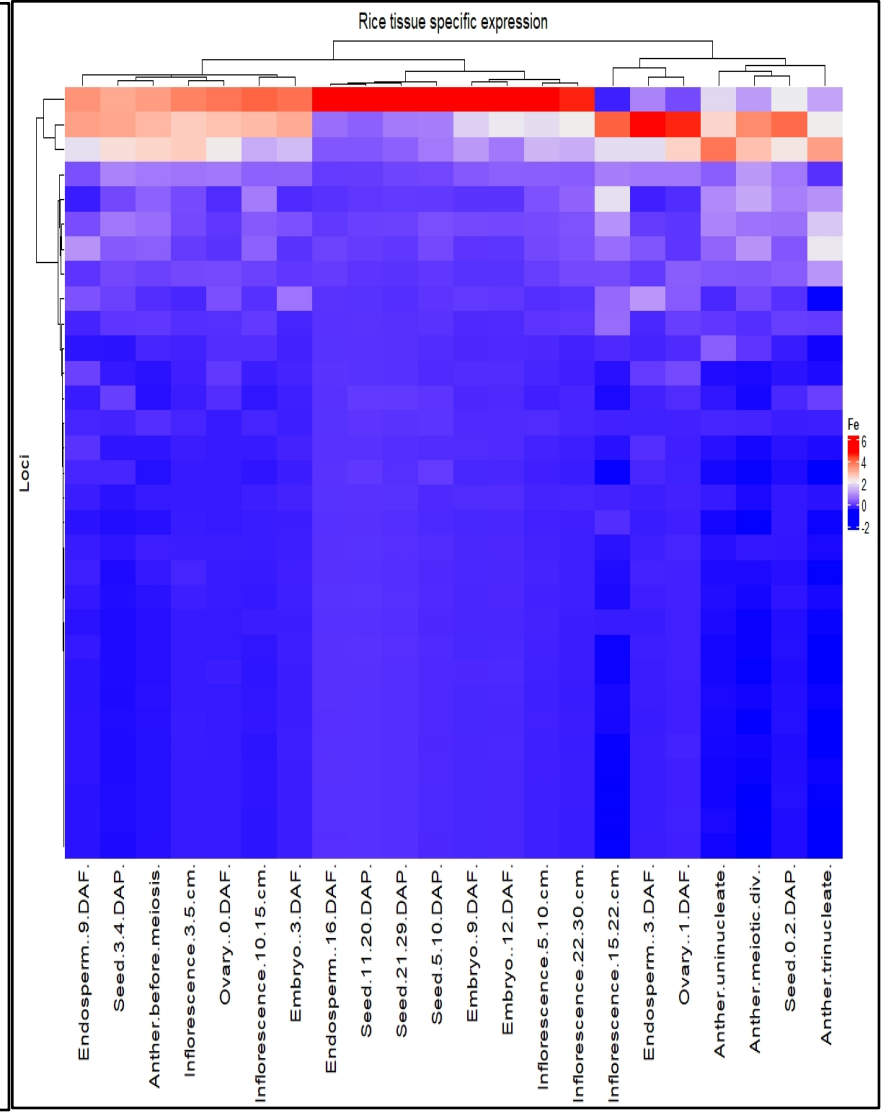
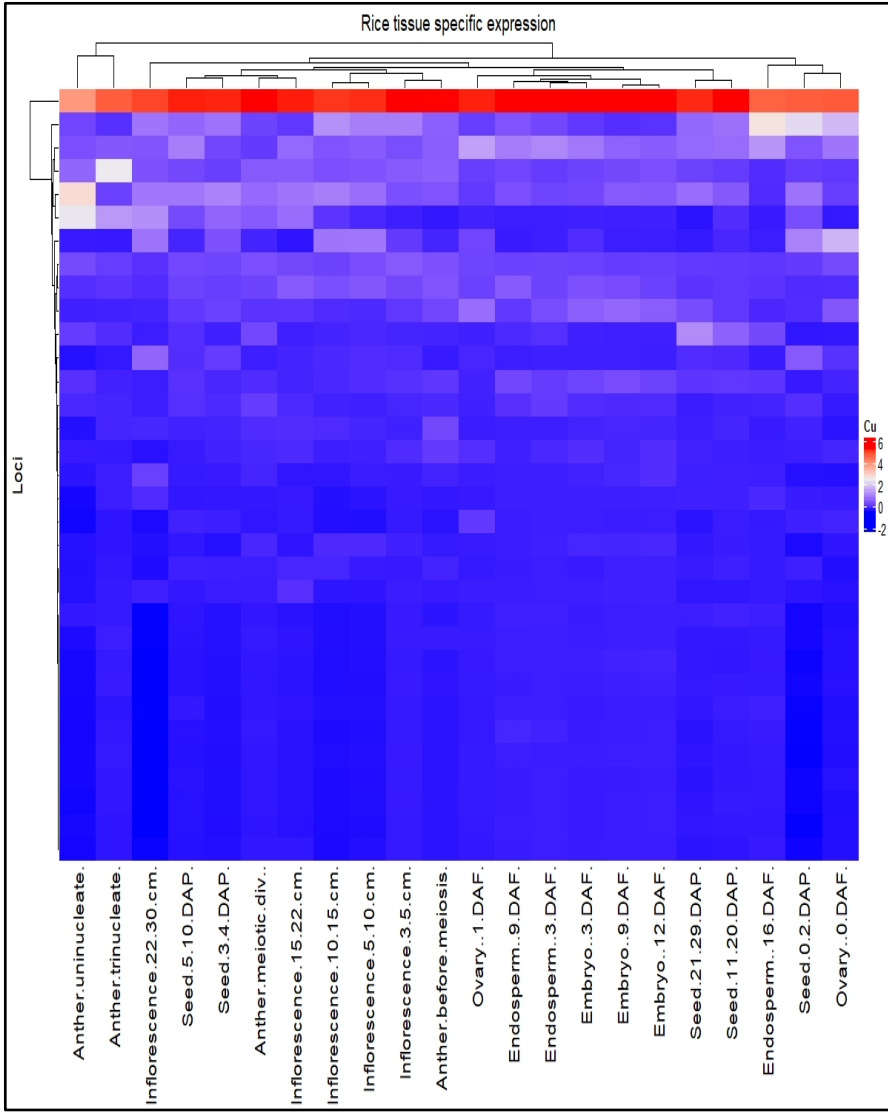
**Figure S3.** Physical map of the significant SNPs at  $-\log_{10}P \geq 3.0$  significant threshold value for six mineral elements. (1) Cu. (2). Fe (3). K (4) Mg (5) Mn (6) Zn. Vertical lines indicate rice chromosomes. The significant SNPs detected in this study are marked as blue color on the left side of the chromosomes. The previously reported genes/markers are displayed as red color on the right of the chromosomes.

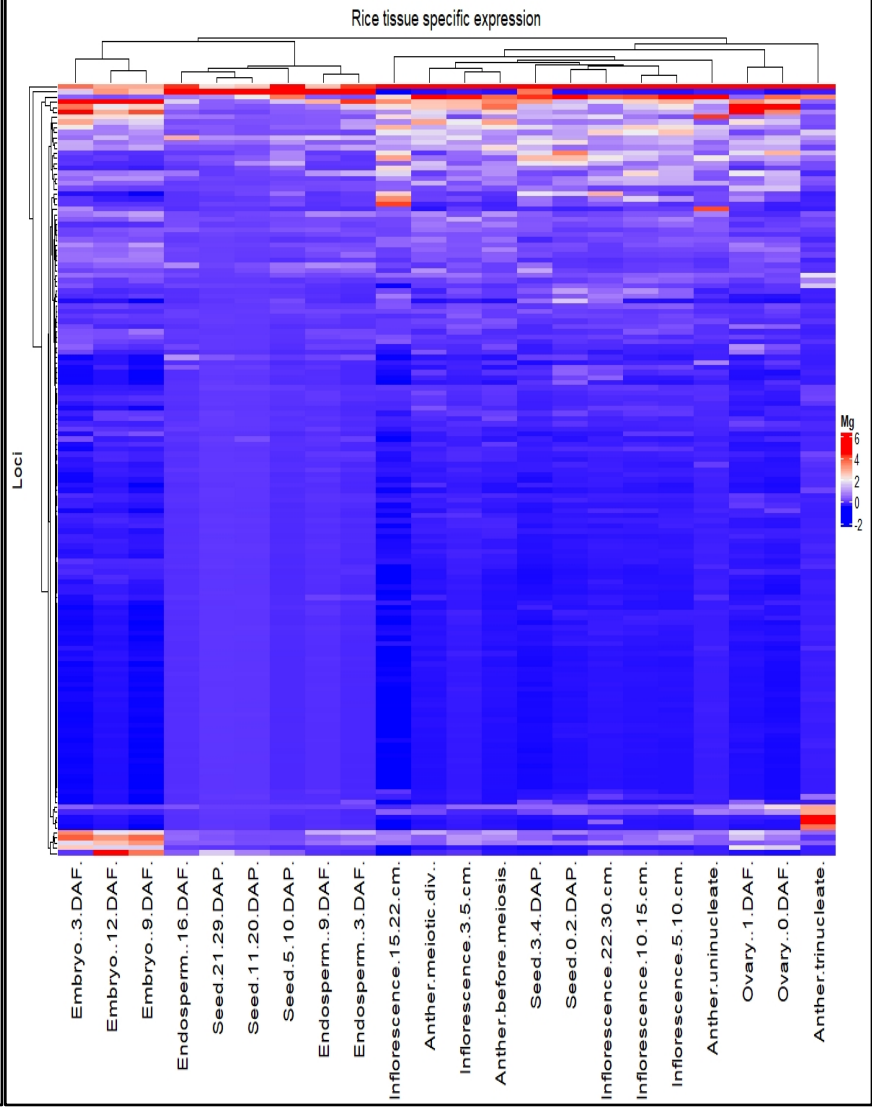
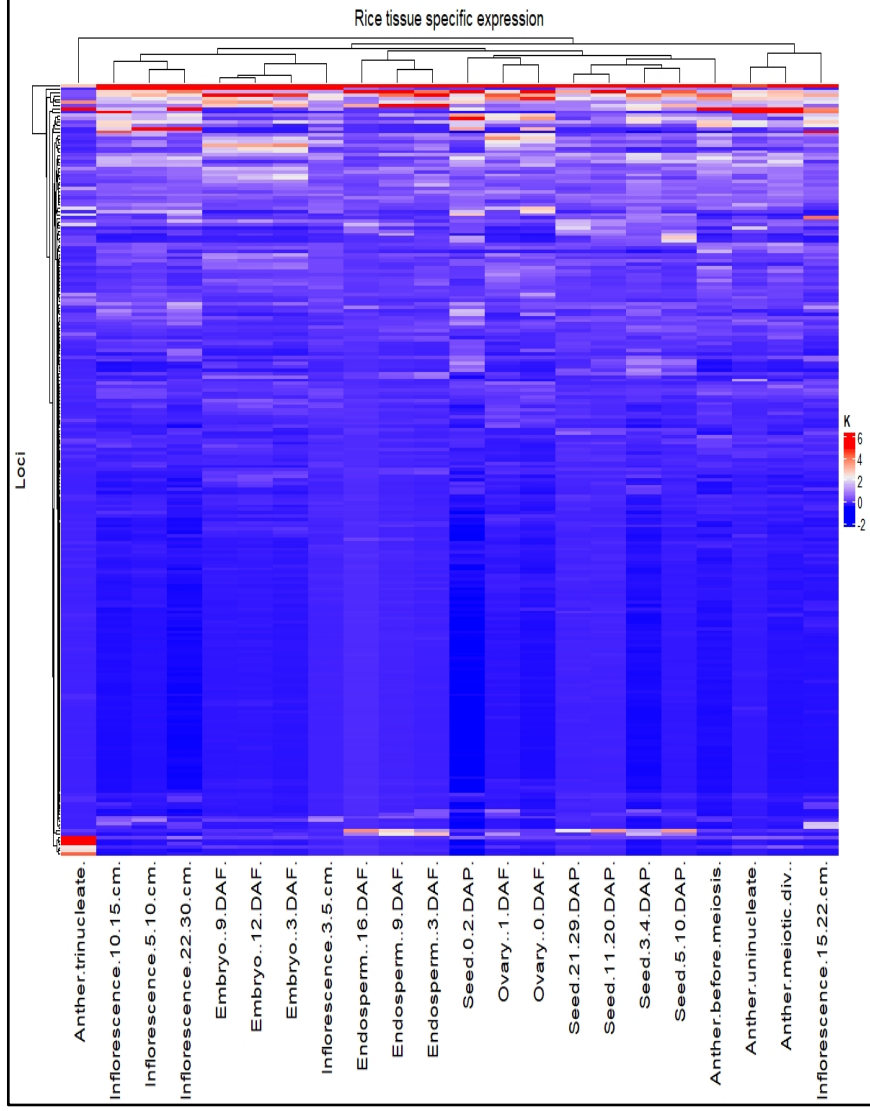


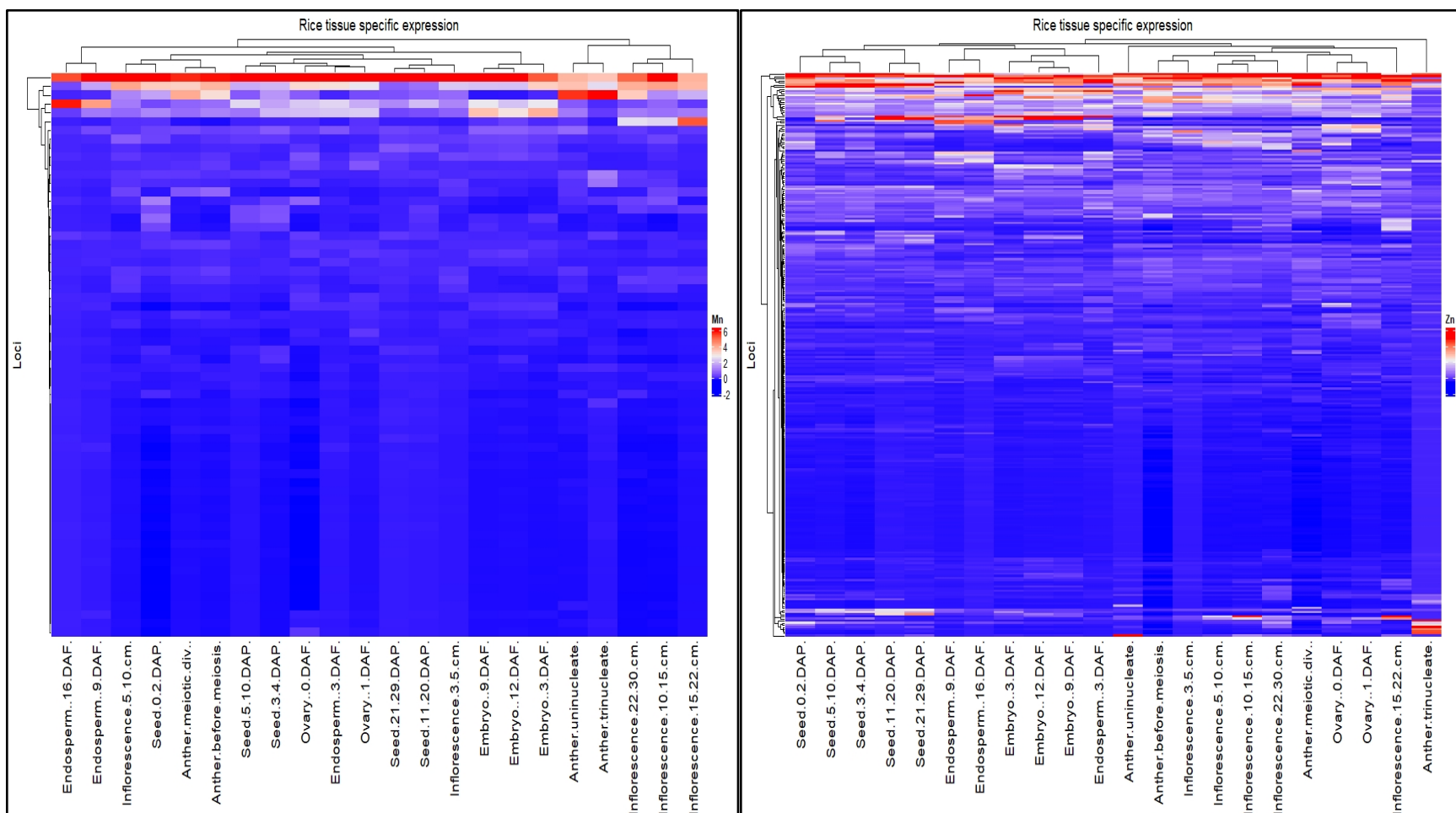




**Figure S4.** Heatmap of In-silico gene expression analysis results for the six mineral elements of the study in Nipponbare. Description of abbreviated terms: L.stage = Leaf stage; L\_20.days.1 = Leaves-20 days; L\_20.days.2 = Leaves-20 days; Endos\_25DAP.1 = Endosperm- 25 DAP; Endos\_25DAP.2 = Endosperm- 25 DAP; Seed\_10DAP = Seed after 10 days of pollination; Seed\_5DAP = Seed after 5 days of pollination; Pr.E.Inflor = Pre-emergence inflorescence; P.E.Inflor = Post-emergence inflorescence; Embryo\_25DAP = Seed embryo after 25 days of pollination.

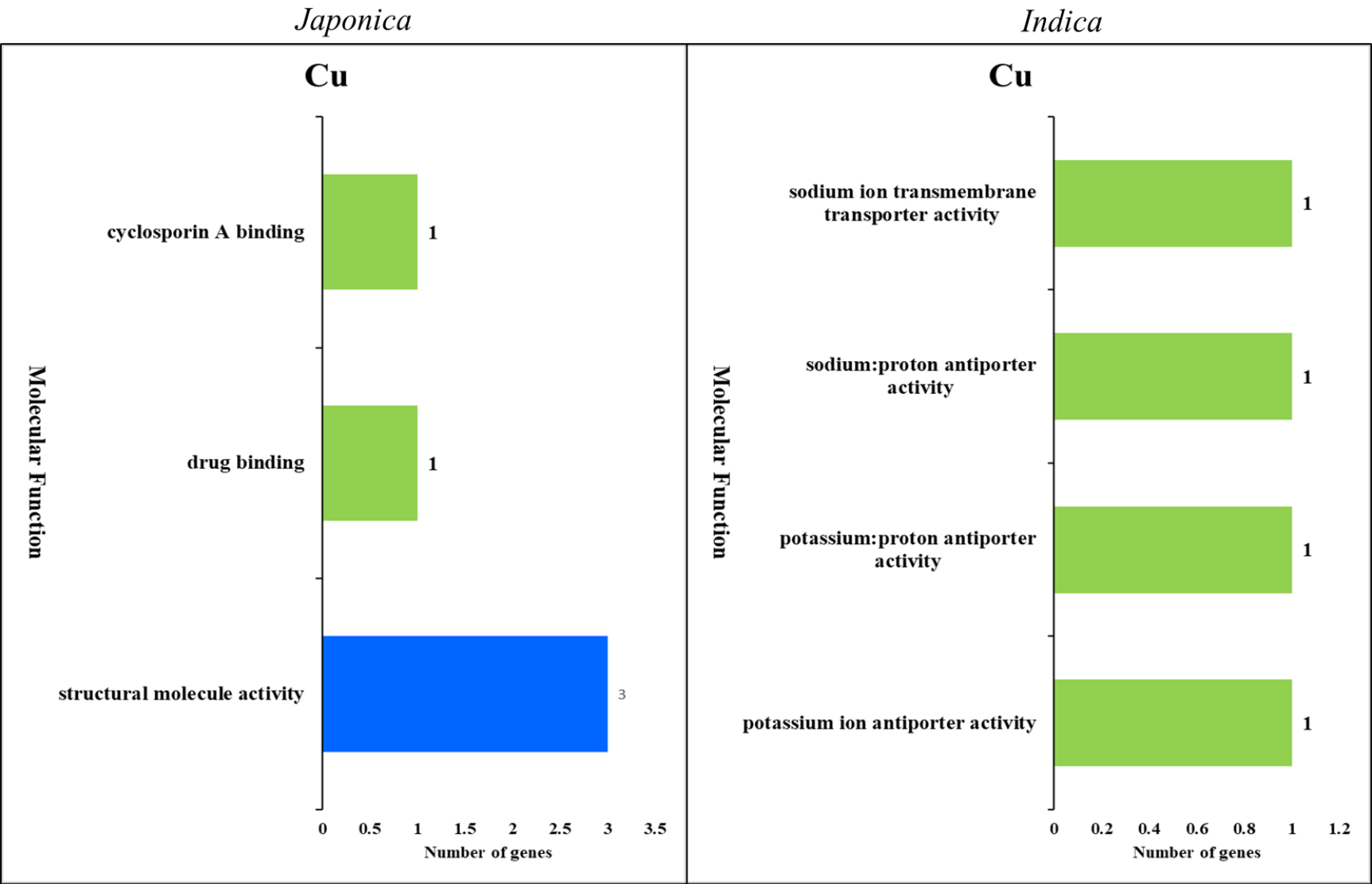






**Figure S5.** Heatmap of In-silico gene expression analysis results for the six mineral elements of the study in IR64. Description of abbreviated terms: Endosperm..16.DAF = Endosperm (16 DAF); Endosperm..9.DAF = Endosperm (9 DAF); Inflorescence.5.10.cm = Inflorescence(5-10 cm); Seed.0.2.DAP = Seed(0-2 DAP); Anther.meiotic.div.. = Anther(meiotic division); Anther.before.meiosis = Anther(before meiosis); Seed.5.10.DAP = Seed(5-10 DAP); Seed.3.4.DAP = Seed(3-4 DAP); Ovary..0.DAF = Ovary (0 DAF); Endosperm..3.DAF = Endosperm (3 DAF); Ovary..1.DAF = Ovary (1 DAF); Seed.21.29.DAP = Seed(21-29 DAP); Seed.11.20.DAP = Seed(11-20 DAP); Inflorescence.3.5.cm = Inflorescence(3-5 cm); Embryo..9.DAF = Embryo (9 DAF); Embryo..12.DAF = Embryo (12 DAF); Embryo..3.DAF = Embryo (3 DAF); Anther.uninucleate = Anther(uninucleate); Anther.trinucleate = Anther(trinucleate); Inflorescence.22.30.cm = Inflorescence(22-30 cm); Inflorescence.10.15.cm = Inflorescence(10-15 cm); Inflorescence.15.22.cm = Inflorescence(15-22 cm).

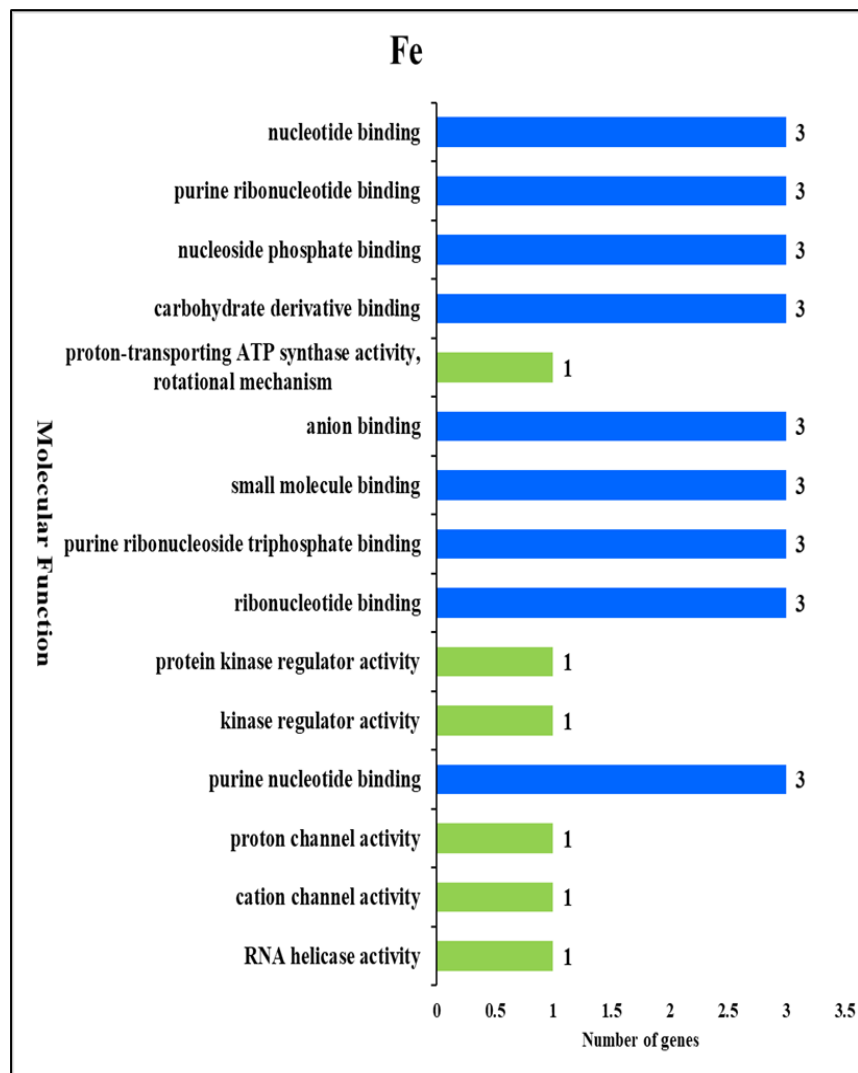
1. Cu



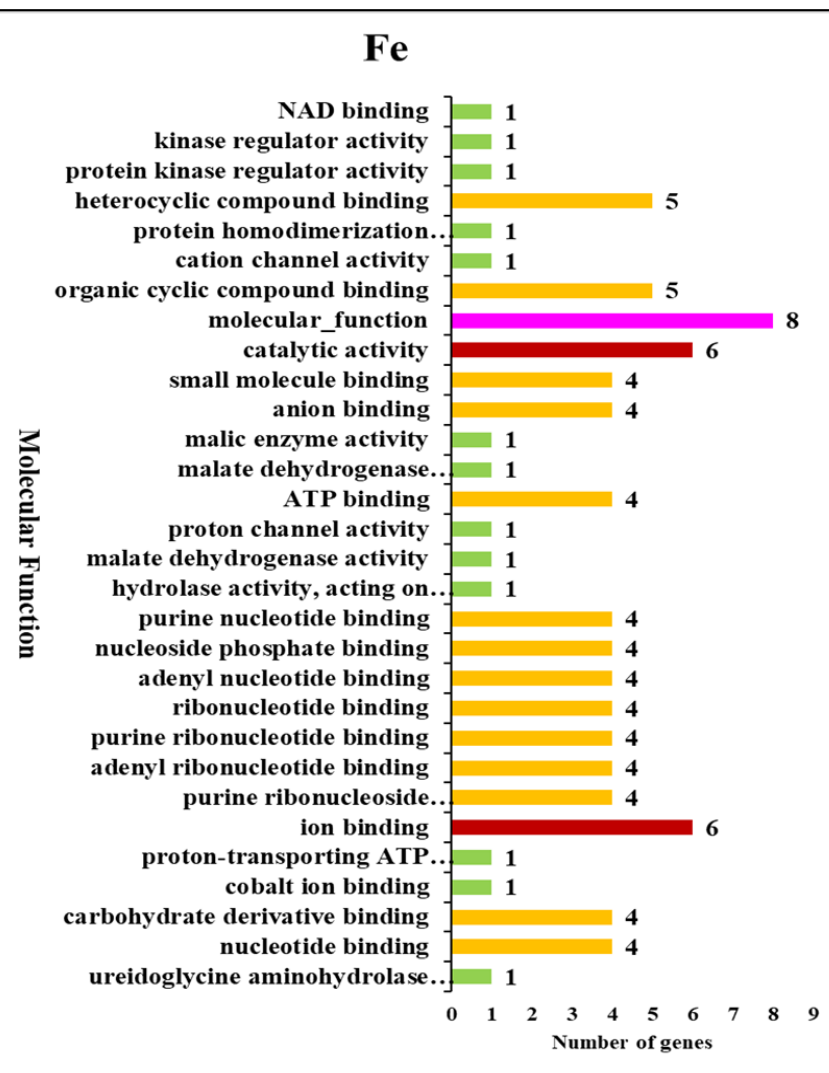


## 2. Fe

### *Japonica*

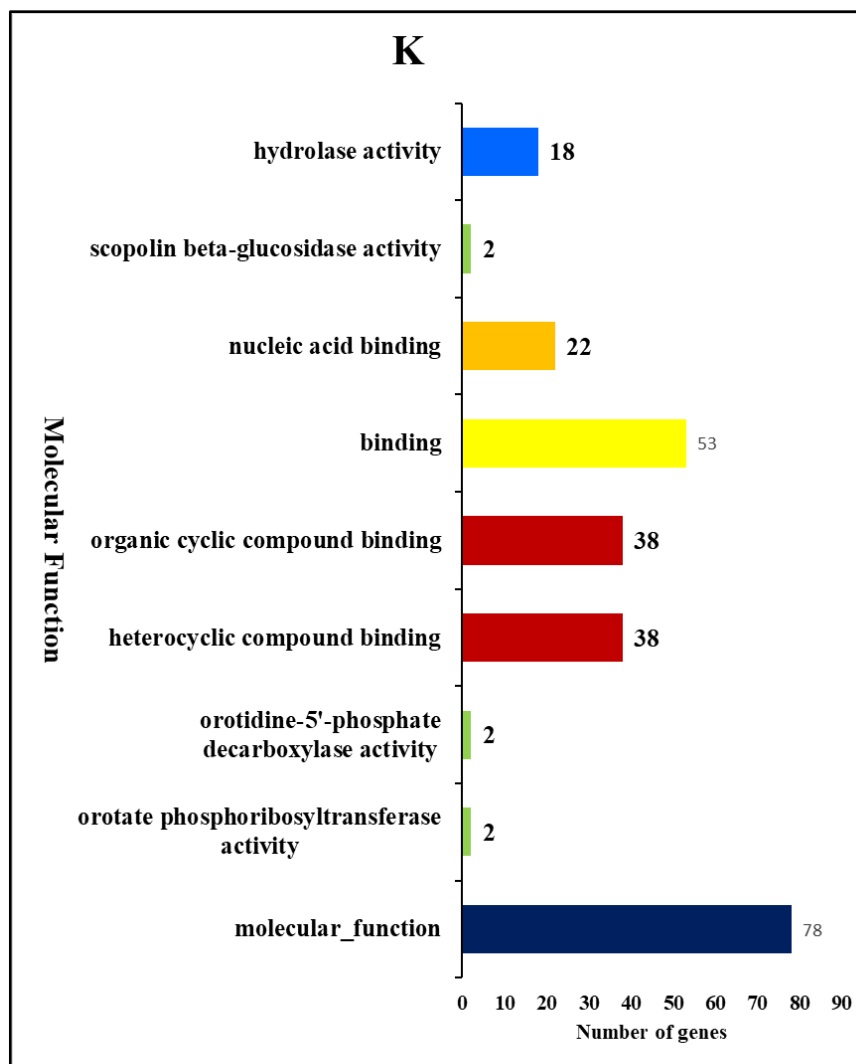


### *Indica*

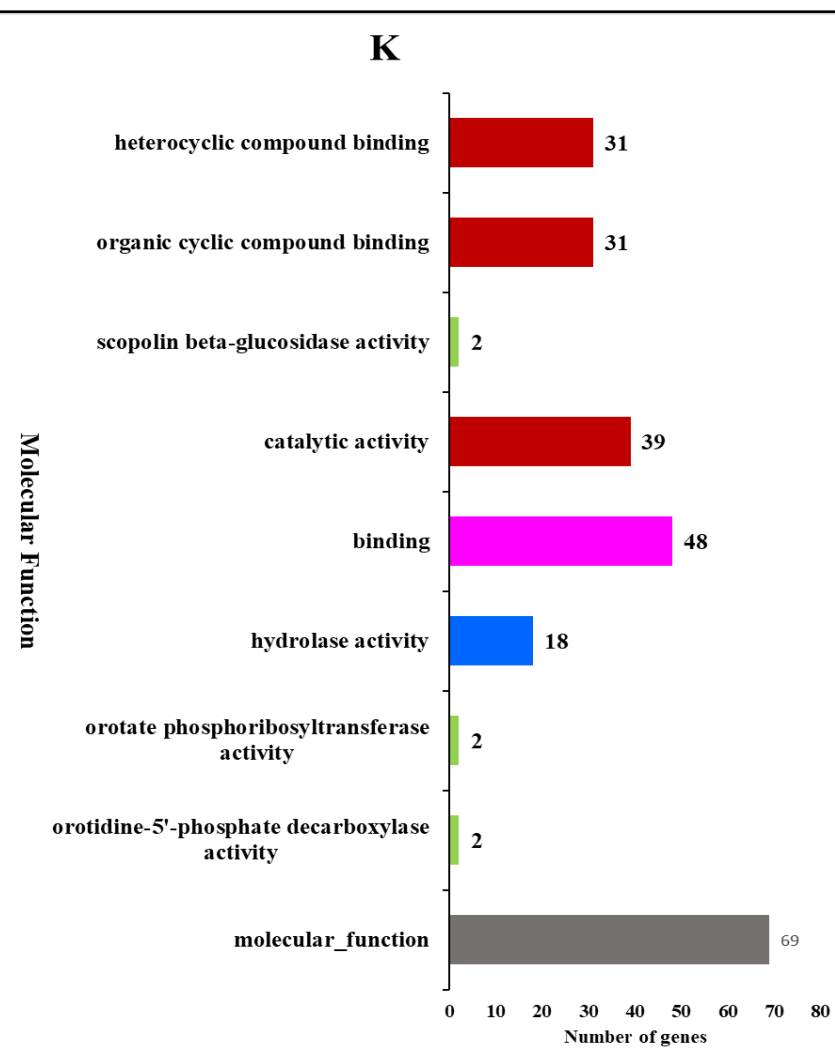


3. K

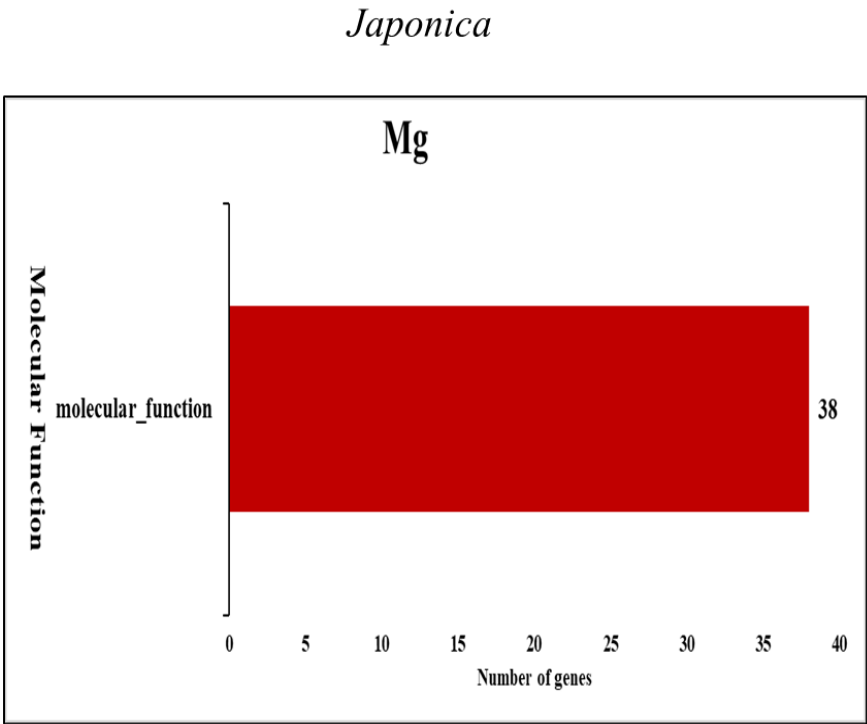
*Japonica*



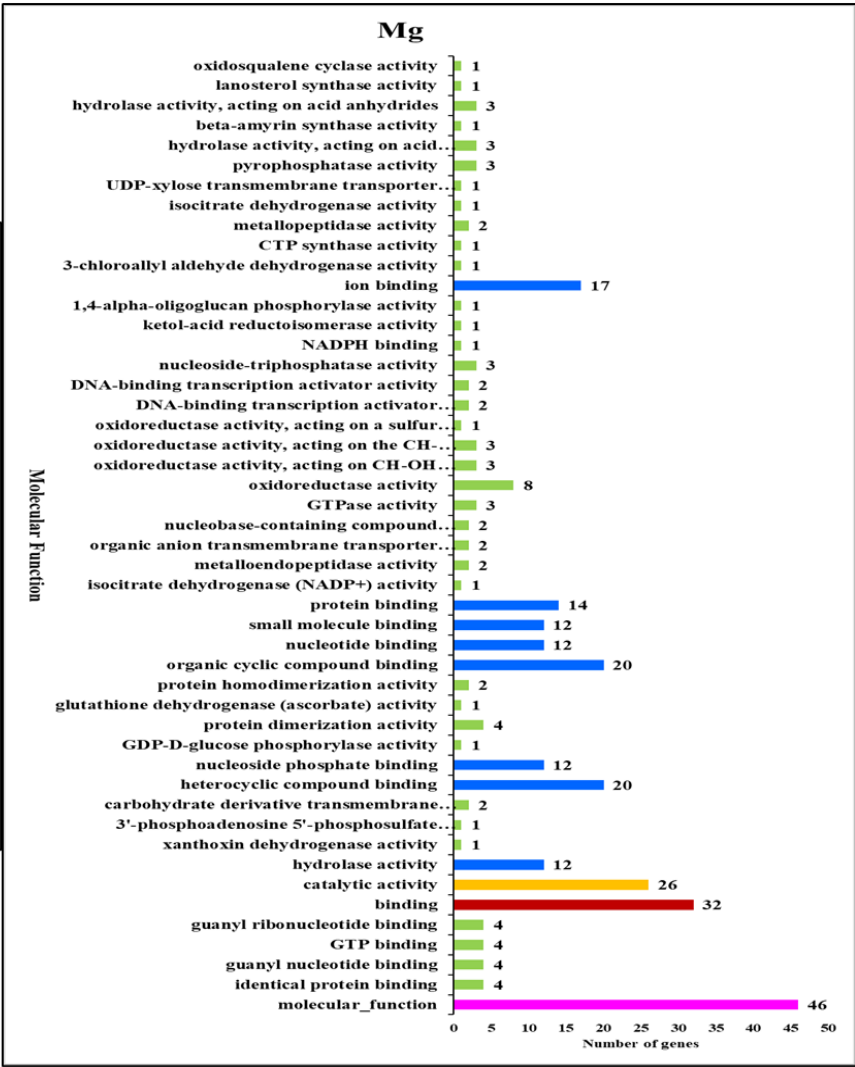
*Indica*



4. Mg

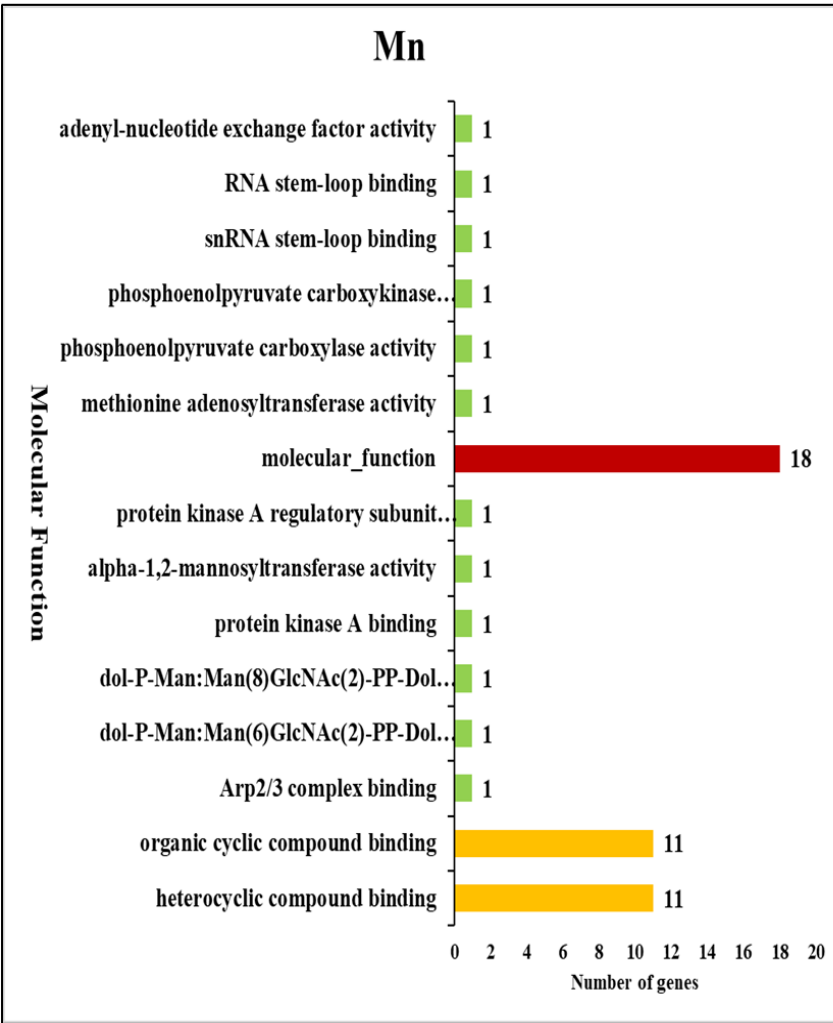


*Indica*

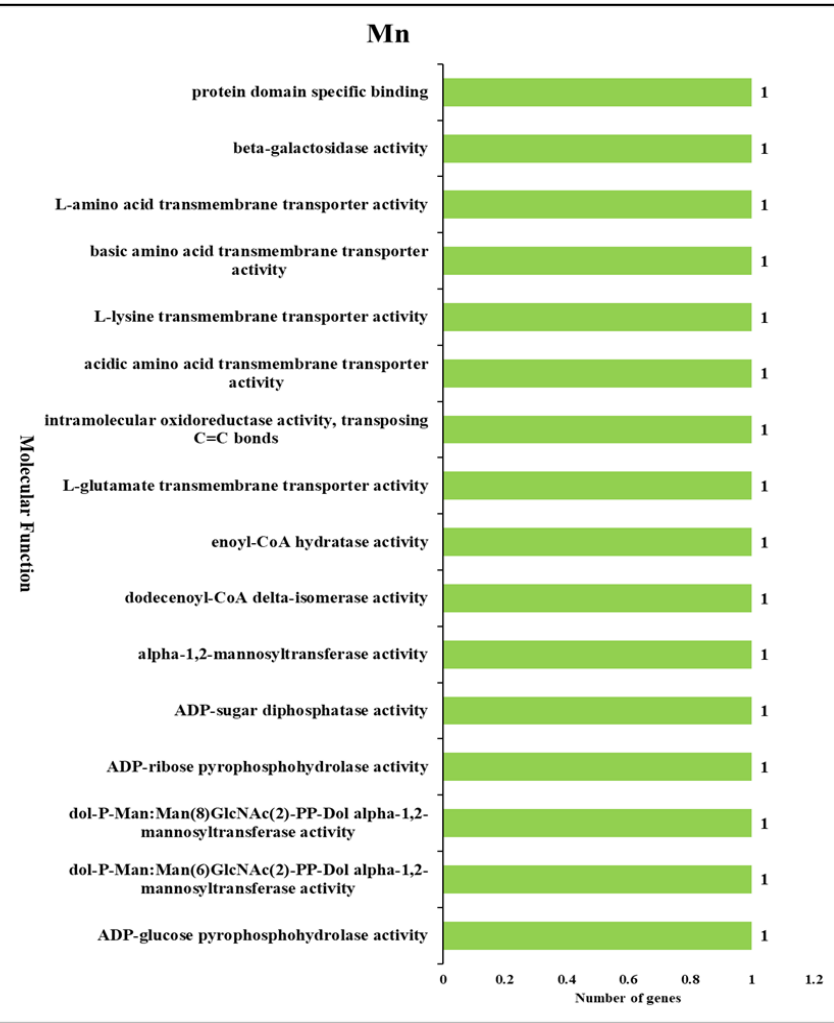


5. Mn

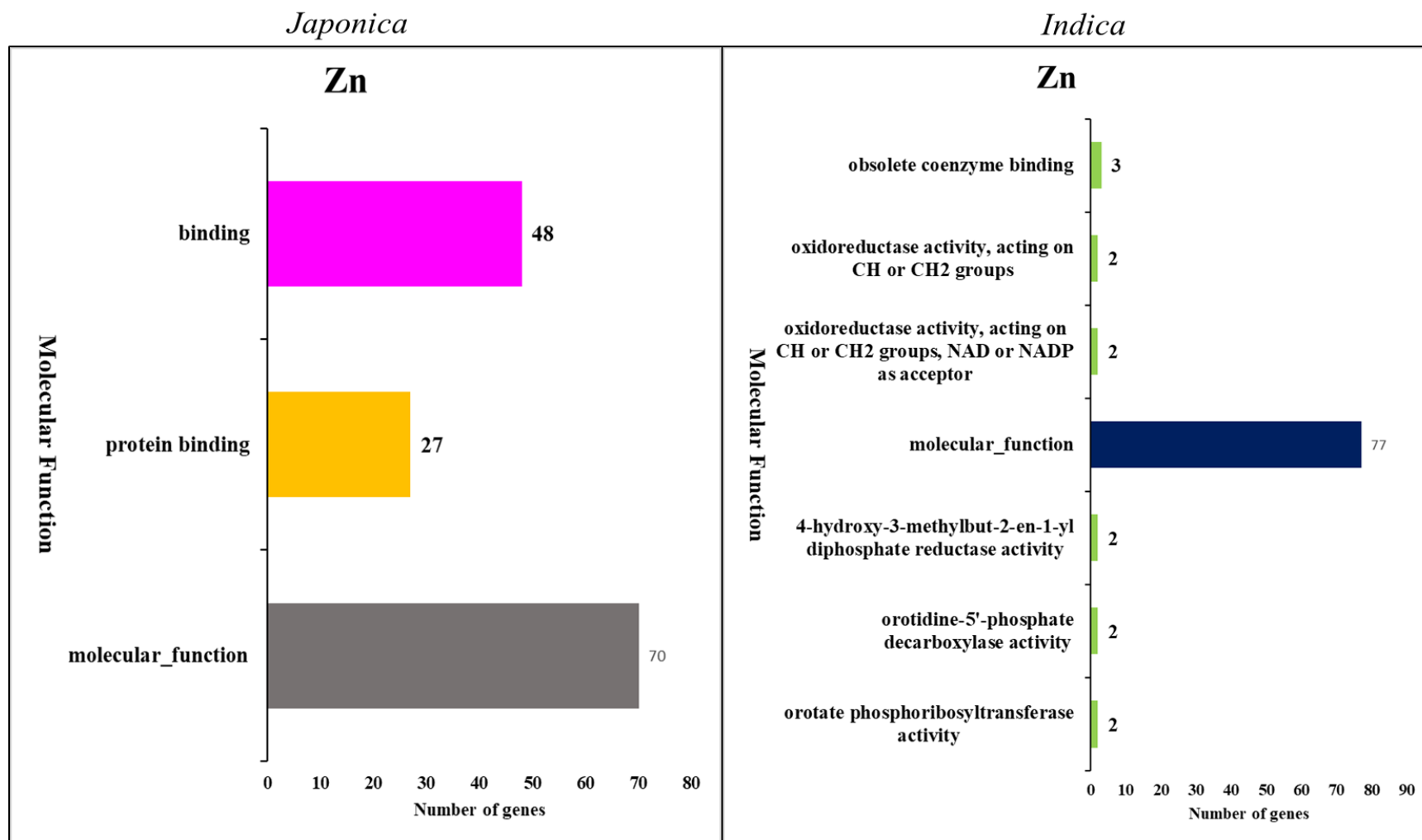
*Japonica*



*Indica*



6. Zn



**Figure S6.** Gene enrichment analysis result, depicting potential molecular functional GO terms for 1.) Cu, 2.) Fe, 3.) K, 4.) Mg, 5.) Mn and 6.) Zn.