**Supplementary table 3** Functions of RING zinc finger proteins in abiotic stress responses and mode of actions

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Gene Name** | **Plant Species** | **Type** | **Function** | **Subcellular Localization** | **References** |
| *AtAIRP1* | *A. thaliana* | RING-HC | Positively regulates plant drought stress responses | Cell membrane | ([Ryu et al., 2010](#_ENREF_62)) |
| *AtAIRP2* | *A. thaliana* | RING-HC | Positively regulates plant drought stress responses | Cytoplasm | ([Cho et al., 2011](#_ENREF_8)) |
| *AtAIRP3* | *A. thaliana* | RING-HC | Positively regulates plant drought and salt stress responses | Cell membrane | ([Kim and Kim, 2013a](#_ENREF_24)) |
| *AtAIRP4* | *A. thaliana* | RING-HC | Positively regulates plant drought stress responses | Cytoplasm | ([Yang et al., 2016](#_ENREF_68)) |
| *AtATRF1* | *A. thaliana* | RING-HC | Enhances aluminium tolerance in Arabidopsis | Nucleus | ([Qin et al., 2017](#_ENREF_61)) |
| *AtATL78* | *A. thaliana* | RING-H2 | Positively regulates drought stress but negatively regulates cold stress | Cell membrane | ([Kim and Kim, 2013b](#_ENREF_28);[Suh et al., 2016](#_ENREF_63)) |
| *AtOHRP1* | *A. thaliana* | RING-HC | Positively regulates plant oxidative stress responses |  | ([Li et al., 2013](#_ENREF_34)) |
| *AtPPRT1* | *A. thaliana* | RING-HC | Positively regulates heat stress but negatively regulates drought and salt stress | Mitochondria | ([Pei et al., 2019](#_ENREF_57);[Liu et al., 2020a](#_ENREF_43);[Liu et al., 2020b](#_ENREF_44)) |
| *AtRZF1* | *A. thaliana* | RING-H2 | Positively regulates plant drought stress responses | Nucleus | ([Ju et al., 2013](#_ENREF_20);[Min et al., 2021](#_ENREF_47)) |
| *DRIP1* | *A. thaliana* | RING-HC | Negatively regulates plant drought stress response | Nucleus | ([Qin et al., 2008](#_ENREF_60)) |
| *DRIP2* | *A. thaliana* | RING-HC | Negatively regulates plant drought stress response | Nucleus | ([Qin et al., 2008](#_ENREF_60)) |
| *EMR* | *A. thaliana* | RING-HC | Involved in the degradation of ER-associated protein | Cytoplasm | ([Park et al., 2018a](#_ENREF_51)) |
| *HOS1* | *A. thaliana* | RING-C2 | Decreases plant tolerance to cold stress | Nucleus | ([Ishitani et al., 1998](#_ENREF_17);[Lee et al., 2001](#_ENREF_30);[Dong et al., 2006](#_ENREF_10)) |
| *NCA1* | *A. thaliana* |  | Positively regulates plant oxidative stress responses | Cytoplasm | ([Li et al., 2015](#_ENREF_33)) |
| *NERF* | *A. thaliana* | RING-HC | Regulator of plant tolerance to drought stress | Nucleus | ([Gao et al., 2015](#_ENREF_12)) |
| *RGLG2* | *A. thaliana* | RING-HC | Negatively regulates plant drought stress response | Plasma membrane | ([Cheng et al., 2012](#_ENREF_7);[Yu et al., 2020](#_ENREF_70)) |
| *RHA2a* | *A. thaliana* | RING-H2 | Positively regulates plant drought stress responses and ABA signaling | Plasma membrane and nucleus | ([Li et al., 2011](#_ENREF_32)) |
| *RHA2b* | *A. thaliana* | RING-H2 | Positively regulates plant drought stress responses and ABA signaling | Plasma membrane and nucleus | ([Li et al., 2011](#_ENREF_32)) |
| *Rma1* | *A. thaliana* | RING-HC | Involves in plant drought stress responses by regulates aquaporin levels | Endoplasmic network | ([Matsuda et al., 2001](#_ENREF_46);[Lee et al., 2009](#_ENREF_31)) |
| *SDIR1* | *A. thaliana* | RING-H2 | Positively regulates plant salt and drought stress responses | Plasma membrane | ([Zhang et al., 2007](#_ENREF_77);[Zhang et al., 2015](#_ENREF_74)) |
| *STRF1* | *A. thaliana* | RING-H2 | Monitor intracellular membrane trafficking and ROS production in response to salt stress | Cytoplasm and Plasma membrane | ([Tian et al., 2015](#_ENREF_64)) |
| *XERICO* | *A. thaliana* | RING-H2 | Positively regulates plant drought stress responses |  | ([Ko et al., 2006](#_ENREF_29)) |
| *OsBIRF1* | *O. sativa* | RING-H2 | Enhance plant tolerance to oxidative, drought stress and disease |  | ([Liu et al., 2008](#_ENREF_39)) |
| *OsCOIN* | *O. sativa* | RING-C2 | Positively regulates plant cold,drought and salt stress responses | Nuclear and cytoplasm | ([Liu et al., 2007](#_ENREF_41)) |
| *OsCLR1* | *O. sativa* | RING-H2 | Positively regulates plant salt and drought stress responses | Cytoplasm | ([Park et al., 2019a](#_ENREF_54)) |
| *OsDIS1* | *O. sativa* | RING-H2 | Positively regulates plant drought stress responses | Nucleus | ([Ning et al., 2011a](#_ENREF_48);[Ning et al., 2011b](#_ENREF_49)) |
| *OsDSG1* | *O. sativa* | RING-H2 | Negatively regulates plant drought stress responses. |  | ([Park et al., 2010](#_ENREF_50)) |
| *OsDIRP1* | *O. sativa* | RING-H2 | Plays an opposite role in drought and cold Stress responses as a negative and positive Factor, respectively | Nucleus | ([Cui et al., 2018](#_ENREF_9)) |
| *OsDHSRP1* | *O. sativa* | RING-H2 | Negatively regulates plant drought, heat and salt stress responses. | Microtubule cytoskeleton | ([Kim et al., 2020](#_ENREF_26)) |
| *OsHCI1* | *O. sativa* | RING-HC | Positively regulates plant heat stress responses | Golgi apparatus | ([Lim et al., 2013](#_ENREF_37)) |
| *OsHIRP1* | *O. sativa* | RING-HC | Positively regulates plant drought stress responses | Nuclear and cytoplasm | ([Kim et al., 2019](#_ENREF_25)) |
| *OsHTAS* | *O. sativa* | RING-H2 | Positively regulates plant heat stress responses | Nuclear and cytoplasm | ([Liu et al., 2016](#_ENREF_40)) |
| *OsMAR1* | *O. sativa* | RING-H2 | Negatively regulates plant salt stress responses. | Related to the microtubules | ([Park et al., 2018b](#_ENREF_52)) |
| *OsRDCP1* | *O. sativa* | RING-HC | Increased tolerance to drought stress in rice | Plasma membrane | ([Bae et al., 2011](#_ENREF_4)) |
| *OsRHP1* | *O. sativa* | RING-H2 | Positively regulates plant drought and salt stress responses |  | ([Zeng et al., 2014](#_ENREF_72)) |
| *OsRZFP34* | *O. sativa* | RING-HC | Positively regulates plant heat stress responses |  | ([Hsu et al., 2014](#_ENREF_15)) |
| *OsRFPv6* | *O. sativa* | RING-HC | Positively regulates plant salt stress responses | Cytoplasm and Plasma membrane | ([Kim et al., 2021](#_ENREF_27)) |
| *OsSADR1* | *O. sativa* | RING-H2 | Negatively regulates plant salt stress responses | Nucleus | ([Park et al., 2018c](#_ENREF_53)) |
| *OsSIRH2-14* | *O. sativa* | RING-H2 | Positively regulates plant salt stress responses | Plasma membrane, cytoplasm, Golgi | ([Park et al., 2019b](#_ENREF_55)) |
| *OsSIRP1* | *O. sativa* | RING-HC | Negatively regulates plant salt stress responses | Cytoplasm | ([Hwang et al., 2016](#_ENREF_16)) |
| *OsSIRP2* | *O. sativa* | RING-HC | Positively regulates plant salt stress responses | Nucleus | ([Chapagain et al., 2018](#_ENREF_6)) |
| *OsSIRP3* | *O. sativa* | RING-H2 | Negatively regulates plant salt stress responses | Cytoplasm | ([Park et al., 2018d](#_ENREF_56)) |
| *OsSIRP4* | *O. sativa* | RING-HC | Negatively regulates plant salt stress responses | Cytoplasm and Plasma membrane | ([Kim and Jang, 2021](#_ENREF_23)) |
| *CaAIRF1* | *C. annuum L.* | RING-HC | Positively regulates plant drought stress responses and ABA signaling | Nucleus | ([Lim et al., 2017](#_ENREF_35)) |
| *CaASRF1* | *C. annuum L.* | RING-H2 | Positively regulates plant drought stress responses | Nuclear and cytoplasm | ([Joo et al., 2019](#_ENREF_18)) |
| *CaATIR1* | *C. annuum L.* | RING-H2 | Positively regulates plant drought stress responses and ABA signaling | Nucleus | ([Joo et al., 2020](#_ENREF_19)) |
| *CaDSR1* | *C. annuum L.* | RING-H2 | Negatively regulates plant salt stress responses | Nuclear and cytoplasm | ([Lim et al., 2018](#_ENREF_36)) |
| *CaRFP1* | *C. annuum L.* | RING-HC | Positively regulates plant osmotic stress responses and enhances disease susceptibility |  | ([Hong et al., 2007](#_ENREF_14)) |
| *CaRZFP1* | *C. annuum L.* | RING-HC | Regulator of root development |  | ([Zeba et al., 2006](#_ENREF_71)) |
| *Rma1H1* | *C. annuum L.* | RING-HC | Positively regulates plant drought stress responses | Endoplasmic network | ([Lee et al., 2009](#_ENREF_31)) |
| *ZmRFP1* | *Z. mays L.* | RING-H2 | Regulator of plant tolerance to drought stress | Plasma membrane | ([Xia et al., 2012](#_ENREF_66)) |
| *ZmXerico1* | *Z. mays L.* | RING-H2 | Positively regulates plant drought stress responses | Cytoplasm | ([Gao et al., 2012](#_ENREF_13);[Brugière et al., 2017](#_ENREF_5)) |
| *ZmXerico2* | *Z. mays L.* | RING-H2 | Positively regulates plant drought stress responses | Cytoplasm | ([Brugière et al., 2017](#_ENREF_5)) |
| *TaDIS1* | *T. aestivuml* | RING-HC | Negatively regulates plant drought stress responses | Golgi apparatus | ([Liu et al., 2018](#_ENREF_42);[Lv et al., 2020](#_ENREF_45)) |
| *TaZnF* | *T. aestivuml* | RING-HC | Positively regulates plant various stress responses |  | ([Agarwal and Khurana, 2018](#_ENREF_1);[2020](#_ENREF_2)) |
| *TaRZF70* | *T. aestivuml* | RING-H2 | Involved in plant drought stress |  | ([Kam et al., 2007](#_ENREF_22)) |
| *AdZFP1* | *A.dracunculus L.* | RING-HC | Positively regulates plant drought stress responses |  | ([Yang et al., 2008](#_ENREF_69)) |
| *BrRZFP1* | *B. rapa* | RING-HC | Positively regulates plant salt and drought stress responses | Cytoplasm and Plasma membrane | ([Jung et al., 2013](#_ENREF_21)) |
| *BdRHP1* | *B.distachyon* | RING-H2 | Positively regulates plant drought stress responses |  | ([ZENG et al., 2019](#_ENREF_73)) |
| *GmARI1* | *G. max* | RING-HC | Enhances plant tolerance to aluminum stress | Nucleus | ([Zhang et al., 2014](#_ENREF_76)) |
| *GmRZFP1* | *G. max* | RING-HC | Positively regulates plant oxidative stress responses | Nucleus | ([WU et al., 2010](#_ENREF_65)) |
| *MeRZF* | *M. esculenta* | RING-H2 | Involved in plant salt stress | Plasma membrane | ([Dos Reis et al., 2012](#_ENREF_11)) |
| *MfSTMIR* | *M. falcata* | RING-H2 | Eliminate endoplasmic reticulum misfolded proteins to alleviate salt stress damage to plants | Endoplasmic network | ([Zhang et al., 2019](#_ENREF_75)) |
| *NtRHF1* | *N. tabacum* | RING-H2 | Positively regulates plant drought stress responses |  | ([Xia et al., 2013](#_ENREF_67)) |
| *SpRing* | *S.lycopersicum* | RING-H2 | Positively regulates plant salt stress responses | Endoplasmic network | ([Qi et al., 2016](#_ENREF_58)) |
| *SlRING1* | *S.lycopersicum L.* |  | Positively regulates plant cadmium (Cd) tolerance | Plasma membrane and nucleus | ([Ahammed et al., 2020](#_ENREF_3)) |
| *StRFP2* | *S.tuberosum L.* | RING-H2 | Positively regulates plant drought stress responses | Cytoplasm and Plasma membrane  | ([Qi et al., 2020](#_ENREF_59)) |
| *SbHCI1* | *S. bicolor* | RING-HC | Positively regulates plant heat stress responses | Cytoplasm and golgi apparatus | ([Lim et al., 2020](#_ENREF_38)) |

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