Advances in Crop Science and Technology

Open Access

Plant Biotechnology and the Future of Drought-Tolerant Crops: Key Developments

Villegas-Escobar*

Research Group CIBIOP, Process Engineering Department, Universidad EAFIT, Colombia

Abstract

Drought is one of the most pressing challenges to global agriculture, threatening food security, especially in regions highly dependent on rain-fed farming. The development of drought-tolerant crops has thus become a critical focus of plant biotechnology research. Advances in genetic engineering, molecular biology, and genomics have enabled the identification and manipulation of key genes and pathways associated with drought tolerance in plants. This paper reviews the latest developments in plant biotechnology for the development of drought-tolerant crops, including the use of genetic modification (GM) and genomic selection, as well as CRISPR/Cas9-based genome editing technologies. We discuss key drought-responsive genes, molecular markers, and transgenic approaches that have shown promise in improving water use efficiency, stress tolerance, and yield stability under drought conditions. The paper also examines the role of synthetic biology, biotechnology-driven breeding, and climate-smart agriculture in overcoming drought-induced challenges. Additionally, we highlight the regulatory, ethical, and economic considerations surrounding the deployment of genetically modified drought-tolerant crops. The future of drought-tolerant crops lies in integrating cutting-edge technologies to create more resilient agricultural systems that can ensure food security in an era of climate change.

***Corresponding author:** Villegas-Escobar, Research Group CIBIOP, Process Engineering Department, Universidad EAFIT, Colombia, E-mail: villegasescobar23@gmail.com

Received: 02-Oct-2024, Manuscript No: acst-24-153007, **Editor Assigned:** 04-Oct-2024, pre QC No: acst-24-153007 (PQ), **Reviewed:** 17-Oct-2024, QC No: acst-24-153007, **Revised:** 23-Oct-2024, Manuscript No: acst-24-153007 (R), **Published:** 29-Oct-2024, DOI: 10.4172/2329-8863.1000753

Citation: Villegas-Escobar (2024) Plant Biotechnology and the Future of Drought-Tolerant Crops: Key Developments. Adv Crop Sci Tech 12: 753.

oo me ae ee c éc and edce , e ma ac of d o g o food od c o [2].

, e , ee b o c , no o g ca ad ace o e ec ng o b e, , ee ema m o a eg a o , e ca, and ec o omc co de a o o d ng , e e of ge ec all ng ee ed d o g - o e a co . eg a o a o a cce e fo C co a g d ca l ac o eg o , o é , de ng , e de ead ado o of , ee ec no o ge , o e, b c ece o of ge ec all mod ed o ga m (G) ema ba e o , e acce ace n ome a of , e o d. ec o omc ab l of d o g - o e a C co a o de é d o fac o c , a co -ec é e , ma e de a d, and nfa c ede e o mé n d o g - o e eg o .

a e a m o o de a o e e of , ec e de e o mé n a b o c , no o g e a ed o , e de e o mé of d o g - o e a co . e ll ea e , e a e ea c , o d o g - e o e ge e , ge e c ng ee ng, ge ome ed ng, and mo ec a b eed ng ec , n e, a e a , e o e of n , ec b o o g and c ma e- ma ag c a ac ce n m o ng d o g e ce. Add o a , e ll d c , ec , a e ge and o o n e a cc a ed , , ec o mec a a o and ado o of , ee ec , no o g e, , a em , a o , e g oba m ca o fo food ec n , e face of c ma ec , ange. B e e ngc é ad ace and f ed c o n , l ed, e o e o o de ng no , e o é a fo a b o c , no o g o m ga e , ee ec of d o g and é e food ec n , ec o ng dcade [3].

Materials and Methods

c o o ne , e ma e a and me , odo o ge ed n d ng , e de e o mé of d o g - o e a co , o g a b o c , no o g. e me , od d c ed n ega e a o b o c , no o gc a a oac e, c , a ge e c ng ee ng, ge ome ed ng, mo ec a b eed ng, and n , ec b o o g, o é , ace d o g e ce nc o . E e me é a de g nc ded , e e of mode a , and ge c em , ge e c ma e , and ad ace ed c , no o g e e C /Ca 9 fo c e ge ome ed ng, a o g , , é o c and mo ec a a a e oa e d o g o e ace e a .

Plant materials

ode a : ee e mé ma l ed mode a c , a A ab.do , a a fo oof-of-c o ce d e de o , e c , ac e ed ge ome, , o fec c e, and ea e of ge e c ma a o . Add o a , ag o omca all m o a co e ma e (*Zea mays*), ce (*Oryza sativa*), o bea (*Glycine max*), and , ea (*Triticum aestivum*) ee a o ed o ea a ed o g o e ace n mo ec om e co c e. ee c e ee c , o é fo , e global m o ace and a ng e e. of d o g é .

Ge e c e o ce: ee d fo m , g - e d ng and d o g - é e c l a ee ed a co o l, and d o g - o e a a e e , e e ace a ee ed fo com a o n a ge c d e [4].

Drought stress treatment

Co o ed D o g e : a ee b ced oc o o ed ae de a o o m a ed o g e . a ac , e ed b ed c ng ga o e e o , , o d ng a e com e e fo d ed e od (ca 5 o 14 da), de é d ng o , ec o c e and e e mé a co d o . D o g e a m o ed a d e é g o , age (e.g., ege a e, o e ng) oa e m ac o a g o , and de e o mé .

a e ng eg me: a e e ego n o , and da d o l med a nde ge é , o ec o d o . ga o a m edd ng , e d o g ea mé e od, , ec o o a e e ma a ed nde o ma ga o . n onec a e, , d o c em e ed fo c ec o o l of a e and é a a ab .

a e e E c éc (E) o o ng: e a e e ec éc of d o g - ea ed a a mo o ed b mea ng , e a o of a b oma o a e o , ngga me co o ab ega ec , nge em fo mea ng a a o and , oo n , e a e [5].

Genetic engineering and transgenic development

Ge e C o ng and a fo ma o : Ca d da e d o g - e o e ge e e e c ed ba ed o o e ac , and , e a a ab of ge nomc da a fo d o g - e a a . Com mo ge e n o ed n d o g o e ace, c , a D EB2, A EB, 5C , and D29A, e e c o ed f om do o a ng C am ca o and n e ed n o a o a e a e e o c o . Ag ob ac e m-med a ed a fo ma o a ed o n od ce a ge e n o A ab.do and c o c e c , a ce and ma e. A e a e , b o c a ce bomba dmé a em o ed fo a fo ma o ofce a c o c e ec o a and , ea .

e c o of a ge c e : a fo med a e e e c ed ba ed o a b.oc e a ce o e c able ma e . cce f l a ge e n ega o a co med ng C a al and o , e bo ng o e f , e e ce ea dco n mbe of , n e ed ge e. E e o of , e a ge e a a e ed ng - C and e e bo ng o mea e m A and o e e e. [6].

Genome editing via CRISPR/Cas9

C /Ca 9 De g : e C /Ca 9 em a em o ed o ed d o g - ea ed ge e n e c ed c o c e. a ge ge e n o ed n a e e o , o mo c ad , mé , o e e o e a , a (e.g., ABA c e o ge e, a a o n) e ec , o é fo

ab ad e ace of d o g - o e a ac o ge e a o .
e o e a ge c a e b ab e d o g e ace, o e
ma o e ee a o e me, m ng e ef e o g- e m
b eed ng og am . ma , o - a ge e c ge ome-ed ed a
m bec o e mo o ed o e e a e dedc a ge do o
com o e a ea o e d. eg a o a o a fo C -
ed edc o a o ema acom e e, d e e co e
ado g a g ace o ge ome-ed edc o , c co d de a
e com mec a a o .

o eo e , e b o c o ogc a a oac e o e g ea o e a,
e o d be ee a com eme a o ad o a b eed ng a e
a a e ace me . Co e o a b eed ng a ac ca o e
m o g d o g o e ace, e c a e de e o ng a e e
a o ed o c c eg o a co d o . eg a ng b o c o og

and e e long- e a abil ag c l e. a oac, ill, el m ga e, e m ac of d o g , le ma a ng o e e c ea ng ag c l al od c .

 c oc l o , a b o ec olog o e mme e o e al fo de elo ng d o g - ole a c o , a ca adde , e g o ng global c, alle ge of a e c ac . , le, el eld, a made g ca og e , , e f e cce of , e ec o de e d o co labo a e e o be ee c e , b eede , o c ma e , a d fa me o e e , a b o ec olog ca be a e ed e o bl a de ec el . B eg a ng ad a ced ge e c ool , a able fa m ng ac ce , d o g - ole a c o co ld become a co e o e of c l ma e- e le ag c l e, el ng o afeg a d global food ec fo f e ge e a o .

References

1. Ademe, Mehiretu (2016) Evaluation of insecticides for the management of tef shoot fy. Adv Crop Sci technol 4: 4-6.
2. Getaneh G, Ayalew G, Derso E (2016) Plant Protection Research in Ethiopia: Major Achievements, Challenges and Future Directions. 199-374.
3. Case Study: Borana, Ethiopia, s.l.: ACSF-Oxfam Rural Resilience Project, Natural Resources, Cornell University; 2014.
4. Sharma HC, Clement SL, Ra GVR (2008) Insect pest management in food legumes: The future strategies. Biology. 1: 522-544.
5. Rajin JC, Thangaraju D, David PMM (2000) Relative abundance of maize stems borer species in Tamil Nadu. Madras Agric J 87: 228-234.
6. In

Joshi Gyaψali S, M