O‘ZBEKISTONDA BUG‘DOY TADQIQOTLARINING KELGUSI ISTIQBOLLARI

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ANNOTATSIYA

Bug’doy ekinini yetishtirish jarayonida o’simliklar biotik va abiotik stress omillar ta’sirida ko’plab to’siqlarga duch keladi, natijada hosil kamayadi. Bu kabi muammolarning yechimi genetika va genomikaning ilg’or texnologiyalarini qo’llagan xoldi chidamli navlarni yaratish hisoblanadi. Ushbu tahliliy maqolada, biz, O’zbeksiton bug’doy tadqiqotlarida qo’llanilishi boshlangan va yaqin kelajakda boshlanadigan tadqiqotlar, genom texnologiyalari borasida ma’lumotlar keltirdik.

Kalit so’zlar. Bug’doy, *Triticum aestivum*, MAS, GWAS, CRISPR/Cas9, poliploidiya, chidamlilik, DNK markerlari, genlar.

ABSTRACT

During wheat cultivation, plants face many challenges under the influence of biotic and abiotic stress factors, resulting in yield decreases. One of the solutions to such problems is the creation of resistant varieties using advanced technologies in genetics and genomics. In this review, we

reported on the genomic technologies being used and will be used in the recent future in Uzbekistan wheat research.

Keywords. Wheat, *Triticum aestivum*, MAS, GWAS, CRISPR/Cas9, polyploidy, resistance, DNA markers, genes.

KIRISH

Dunyo aholisining yil sayin ortib borishi sababli don mahsulotlariga bo'lgan talab ham ortib bormoqda. 2050 yilga kelib, dunyo aholisi 9,8 milliardga qadar o'sib borishi kutilmoqda [40], bu esa oziq-ovqat mahsulotini ikki barobarga oshirishni talab etadi. Xususan, so'nggi 10 yil ichida dunyo aholisining o'sish sur'ati 1,1% atrofida bo'lgan bo'lsa, bu davrda bug'doy donini ishlab chiqarish 1,8% ni tashkil etgan. Agar aholining o'sish sur'atlarini bug'doy yetishtiriladigan maydonlarni kengaytirish imkoniyatlari bilan taqqoslansa, keyingi avlodni don bilan ta'minlashda jiddiy muammolar paydo bo'lishi mumkin [24]. Bu muammoning asosiy yechimlaridan biri, salbiy ta'sir etuvchi, biotik va abiotik omillarga bardoshli, hosildor va yuqori sifatli bug'doy navlarni yetishtirishdan iborat. Birinchi navbatda ushbu talablarga to'liq javob beradigan birlamchi manbalarni (donorlarni) aniqlab, zamonaviy usul va texnologiyalar bilan foydalanilgan holda [17], jumladan, Markerlarga asoslangan seleksiya (MAS), genlar espressiyasi tahlili, butun-genom assotsiatsiyalar tahlili (GWAS – *ingl*. Genome Wide Association Study), poliploidiya va CRISPR/Cas9 kabi ilg'or texnologiyalarni qo'llash selektsiya jarayonlarini qisqartirish, aniqligini va samaradorligini oshirish imkonini beradi.

ADABIYOTLAR TAHLILI VA METODOLOGIYA

Markerlarga asoslangan selektsiya va genlarni piramidalash

Suv tanqisligi, issiqlik va sho'rlanish kabi abiotik stresslar hamda zararkunanda hasharotlar va kasalliklar biotik stress kabi omillar, bug'doydan sifatli va yuqori hosil olishga to'sqinlik qiluvchi eng asosiy omillardir [39,41,42]. Ular genlarning o'zaro munosabati bog'lanishiga salbiy ta'sir ko'rsatib, o'simliklarda murakkab o'zgarishlarni keltirib chiqaradi [1,3,8,19,21]. Tadqiqotchilar, bug'doy hosili va sifatini yaxshilash uchun ushbu stress omillariga chidamli navlar va genotiplarni aniqlash, tavsiflash va selektsiya qilishga e'tibor qaratishmoqda. Ushbu seleksiya morfologik, fiziologik va molekulyar markerlarga asoslangan holda amalga oshiriladi. Morfologik markerlar ko'zga ko'rinadigan belgilardan ildiz yoki gul morfologiyasi, erta pishish va donlarning biomassasi hisobga olinadigan ba'zi muhim parametrlardir. Fiziologik va biokimyoviy markerlar xlorofill tarkibini, prolin, saxaroza to'planishini, stressdan himoya qiluvchi

moddalarni, membrananing barqarorligini va gormonlar tarkibini aniqlaydi. Molekulyar markerlar abiotik va biotik stresslarga chidamlilik mexanizmlari, transkriptsiya omillari va metabolitik yo'l bilan bog'liq genlarni o'z ichiga oladi [34].

Bugungi kunda tadqiqot guruhimiz tomonidan, O'zbekiston Respublikasi Prezidenti huzuridagi Orolbo'yi xalqaro innovatsiya markazida markerlarga asoslangan selektsiya texnologiyasi asosida bahorgi bug'doyning sho'rga, issiqqa va qurg'oqchilikka chidamli, yuqori oqsil tarkibli yangi navlarini olish bo'yicha tadqiqotlar olib borilmoqda. Shuningdek, Genetika va o'simliklar eksperimental biologiyasi institutida X.To'raqulov va D.Erjigitovlar tomonidan, genlarni piramidalash texnologiyasi asosida kuzgi bug'doyning zang kasalligiga chidamli, yuqori harorat, sovuqqa va qurg'oqchilikka bardoshli navlarini yaratish ustida tadqiqotlar olib borishmoqda [22]. Bundan tashqari, U.Baxodirov va S.Baboev kabi olimlar tomonidan, markerlarga asoslangan selektsiya texnologiyasi asosida kuzgi bug'doyning shiraga chidamli yangi navlarini yaratish borasida izlanishlar olib borishmoqda [4].

Markerlarga asoslangan selektsiya texnologiyasi o'zining vaqt va boshqa qimmatli resurslarni tejab qolishi, tezkor va aniq tanlovni amalga oshirishi bilan O'zbekiston bug'doy selektsiyasini yangi bosqichga olib chiqadi. Kelgusida bug'doy selektsiyasida MAS texnologiyasining keng ko'lamda ko'llanilishi kasallik va zararkunandaga chidamli, atrof muhitning noqulay sharoitlariga moslashgan yangi navlarni tez va samarali selektsiya qilish imkonini beradi.

Degidrin kodlovchi genlarning tadqiqi

Degidrin oqsillari oilasi donli ekinlarda qurg'oqchilik va sovuqqa chidamlilikda muhim rol o'ynovchi himoya oqsillari hisoblanadi [9,10,12,25,28]. Degidrinlar bo'yicha ko'p yillik tadqiqotlar amalga oshirilganligiga qaramay, bug'doy degidrinlari qurg'oqchilikka chidamlilikni oshirishi borasida ishonchli dalillar yetarlicha emas. Ilmiy nashrlar degidrinlarni kodlovchi genlarning qurg'oqchilik stressiga javob mexanizmlaridagi ahamiyati, faoliyati va ta'siri haqida to'liq ma'lumot bermaydi [28]. Kelgusida, qurg'oqchilikka chidamlilikda yumshoq bug'doy degidrinlarini kodlovchi individual genlarning rolini o'rganish maqsad qilingan. Bunday tadqiqotlar bug'doyning suv tanqisligiga chidamliligi uchun markerlarga asoslangan selektsiya texnologiyasini rivojlantirishga imkon beradi.

Hozirda, Genetika va o'simliklar eksperimental biologiyasi institutida Innovatsion rivojlanish agentligi tomonidan moliyalashtirilgan "Qurg'oqchilikka chidamli istiqbolli navlarni yaratish uchun samarali molekulyar markerlarni ishlab chiqish maqsadida degidrin-kodlovchi genlarning yumshoq bug'doyning qurg'oqchilikka

chidamlilikdagi hissasini aniqlash" mavzusida "O'zbekiston-Belarus" xalqaro fundamental loyihasi amalga oshirilib kelmoqda. Ushbu tadqiqot natijasida, genetik jihatidan kelib chiqishi turlicha bo'lgan yumshoq bug'doy navlarining qurg'oqchilikka chidamliligida eng ko'p hissa qo'shadigan degidrin-kodlovchi genlar va ularning nukleotid ketma-ketliklari aniqlanadi. Shu bilan birga, qurg'oqchilik sharoitida mazkur genlarning ekspressiya darajasi o'rganiladi. Yumshoq bug'doy genotiplarining suv tanqisligiga chidamlilik darajasini baholash hamda bug'doy selektsiyasi uchun molekulyar usullar ishlab chiqiladi. Qurg'oqchilikka chidamli bug'doy genotiplari hamda ushbu belgi bilan assotsiatsiyalangan genetik markerlar aniqlanadi va selektsiya tadqiqotlariga yo'naltiriladi.

Poliploidiya usulida bug'doy genomini oshirish

Seleksiyada turli genomli o'simliklarni o'zaro duragaylash va ulardan avlod olish juda murakkab vazifa hisoblanadi [18,23,26,]. Shu sababli, qishloq xo'jaligi ekinlarining yovvoyi ajdodlaridagi qimmatli xo'jalik belgilarini mahalliy navlarga introgressiya qilishda qiyinchiliklarga duch kelinadi. Xususan, *Aegilops tauschii* diploid (D genomli) turi hozirda butun dunyoda eng ko'p yetishtiriladigan geksaploid (AABBDD genomli) yumshoq bug'doy *Triticum aestivum* L. turining yovvoyi ajdodi hisoblanadi [6,13]. Geksaploizidatsiya jarayoni tahminan 8 ming yil oldin sodir bo'lgan. Bunda, diploid *Aegilops tauschii* turi tetraploid *Triticum turgidum* turi bilan tasodifiy duragaylanib qolgan [13,30].

Diploid, tetraploid va geksaploid genomli organizmlarning o'zaro duragaylanishidagi murakkabliklarni hisobga olgan xolda, poliploidizatsiya usulini qo'llash eng maqbul yo'l hisoblanadi. Hozirda, Genetika va O'EB instituti olimlari tomonidan bug'doyning *Aegilops tauschii* turi genomini kolxitsin moddasi ta'siri asosida tetraploidga oshirish ustida izlanishlar olib borilmoqda. Kelgusida, olingan poliploidlarni boshqa tetraploid turlar bilan duragaylash, olingan duragaylar genomini gekcaploidga oshirish rejalashtirilgan. Bu esa diploid va tetraploid genomli bug'doy turlaridagi qimmatli genlar majmuini mahalliy yumshoq bug'doy navlariga introgressiya qilish imkonini beradi.

Bug'doy tadqiqotlarida GWAS va CRISPR/Cas9 texnologiyalarini qo'llash

Butun-genom assotsiatsiyalar tahlili (GWAS). GWAS ko'plab qishloq xo'jaligi ekinlarida agronomik muhim belgilar bilan bog'liq bo'lgan miqdoriy belgilar lokuslarini (QTL) aniqlash uchun keng qo'llaniladi [11,17,32,35] . Yuqori samarali yagona nukleotid polimorfizmi (SNP)ga asoslangan mikrochip texnologiyasi genotiplash platformalarini ishlab chiqish o'simliklarda GWAS tahlilini amalga oshirish imkonini berdi va

murakkab belgilar uchun QTL va allel o'zgarishini aniqlash uchun samarali yondashuvga aylandi. GWAS bug'doyda abiotik stressga chidamlilik [27,29], hosil komponentlari, don sifati yoki kasalliklarga chidamlilik [5,31] bilan bog'liq QTL hududlarini aniqlash uchun muvaffaqiyatli qo'llanildi. Biroq, hozirgi kunga qadar, O'zbeksitonda GWAS texnologiyasini qo'llash bo'yicha genetik tadqiqotlari amalga oshirilmagan.

Genlarni tahrirlashning CRISPR/Cas9 texnologiyasi. Genomni tahrirlash molekulyar biologiya tadqiqotlari uchun, ayniqsa murakkab genomlarga ega bo'lgan o'simliklar uchun uzoq muddatli muammo bo'lib kelgan [33]. So'ngi yigirma yil davomida kashf etilgan CRISPR/Cas9 (*ingl*. Clustered Regularly Interspaced Short Palindromic Repeats/CRISPR-associated protein 9) tizimi kichik RNKlarni boshqarish asosida bir nechta genlarni tahrirlash imkonini beruvchi genomni tahrirlash uchun ko'p qirrali vositadir [14]. CRISPR/Cas9 tizimining samaradorligi diploid o'simliklarda olib borilgan bir nechta tadqiqotlarda ko'rsatilgan bo'lsada, uni qo'llash poliploid va murakkab genomli o'simliklar uchun qiyinligicha qolmoqda [16]. Shunga qaramasdan, mukrakkab genomli geksaploid bug'doyda CRISPR/Cas9 texnologiyasini muvaffaqiyatli qo'llash borasida tadqiqot natijalari mavjud [2,7,15,20,36,37,38]. Nufuzli ilmiy jurnallarda O'zbeksitonda CRISPR/Cas9 texnologiyasining muvaffaqiyatli qo'llanilishi bo'yicha birorta ham ilmiy tadqiqot natijalari keltirilmagan. Ushbu texnologiyaning O'zbekiston bug'doy tadqiqotlarida qo'llanilishi bug'doy seleksiyasidagi mavjud muammolarni gen muhandisligi yo'li bilan tez va samarali hal etish imkonini beradi.

XULOSALAR

O'zbekistonda bug'doyning genetik va genom tadqiqotlarida GWAS, MAS, poliploidiya va CRISPR/Cas9 texnologiyalarini qo'llash, qimmatli xo'jalik belgilarga aloqador genlarni yuqori aniqlikda identifikatsiya qilish, ikkita va undan ortiq genlarni bir genotipga jamlash, genetik to'siqlarni bartaraf etish hamda genlarni maqsadli boshqarish imkonini beradi.

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