灌浆期高温对小麦籽粒蛋白质积累和品质影响的研究进展

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摘要:小麦花后常遇高温胁迫,显著影响小麦产量和品质。为了探讨高温热害对小麦品质影响的内在原因,现对灌浆期高温胁迫对小麦籽粒各蛋白组分积累及品质方面的影响进行了综述。总体来看,高温均使小麦籽粒各蛋白质组分含量提高,当处于适度高温时,面团强度增强,小麦品质提高;当温度大于30℃形成高温胁迫时,影响谷蛋白大聚体的形成,导致面团强度变弱。进一步探讨了抗高温育种策略,以期为培育品质稳定型小麦品种提供依据。

关键词:小麦;花后高温;蛋白积累;品质
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小麦品质是决定小麦最终用途的标准,也是衡量小麦质量好坏的依据。在遗传学上,小麦品质既受遗传控制,也受环境条件变化影响[1-2]。在众多环境因素中,灌浆期温度被认为是影响小麦品质的主要因素。小麦灌浆期遇到高温和热害,可使小麦籽粒蛋白含量升高,但同时也降低了蛋白的功能特性[3-4]。在世界范围内,小麦灌浆期遇到阶段性高温是较为常见的现象[5-6]。在我国小麦主产区花后常遇干热风天气引起小麦减产[7-8]。随着全球气温的不断升高,出现极端高温天气的频率也随之增加。小麦生育期间温度的大幅度变化将给未来小麦生产带来更大影响[9]。培育灌浆期抗(耐)热性的小麦品种是降低高温对小麦生产影响的最经济且有效的方法[10]。明确气温升高对小麦产量和品质的影响以及如何提高小麦灌浆期抗(耐)热能力,使培育出的小麦新品种能够适应未来气候变化已成为当前国际小麦育种中的重要研究方向[8,11]。

1　灌浆期高温胁迫对籽粒蛋白质积累的影响

目前,国内外许多学者在小麦灌浆期温度变化对籽粒蛋白组分和品质的影响程度方面进行了大量研究。Wardlaw 和 Gooding 等指出,高温胁迫可使小麦籽粒中淀粉产量降低,蛋白质含量明显提高[12-13]。Castro 等认为,在高温胁迫条件下常导致小麦籽粒干瘪,虽然提高了籽粒蛋白质含量,但蛋白质的总体产量降低[14]。Skylas 等研究结果认为,高温胁迫对各蛋白组分含量也有不同影响。在高温胁迫下,可使籽粒中清蛋白、球蛋白、可溶性谷蛋白聚合体及醇溶蛋白等的相对含量增加,不溶性谷蛋白聚合体相对含量降低;醇溶蛋白与麦谷蛋白比率升高,同时影响谷蛋白大聚体的形成,导致面

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Analysis on Influence Factors of Social Stability Risk of Agricultural Project

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Abstract: Social stability risk analysis is content of the risk analysis in the project feasibility study. Through introducing the origin, field and grade, the influence factors of social stability risk in agricultural project were analyzed, some attentions and suggestions were put forward for researchers.
Keywords: agricultural project; social stability risk analysis; influence factors

团强度变弱,面粉揉混时间和耐揉性降低[4,15-21]。高温对籽粒蛋白质积累的影响程度还与氮肥水平直接相关。DuPont 等在两种温度水平下(24℃/17℃和 34℃/17℃)研究表明,小麦开花后施加氮肥时,两种温度下的籽粒蛋白组分和含量没有显著差异,但是花后不施加氮肥在两种温度下的籽粒蛋白组分和含量明显不同[22]。

2　灌浆期高温胁迫对品质的影响

Schipper 等研究结果认为,小麦灌浆期处于适度高温时,可使面团延伸性增加,面包体积增大[23]。Randall 等和 Wrigley 等利用人工气侯室和温室相结合以及田间记录温度等方法,研究短期及长期高温对小麦品质影响时发现:当小麦灌浆期处于适度高温时,可通过提高籽粒蛋白质含量,导致面团强度增强,提高小麦品质;当温度大于 30℃形成高温胁迫时,虽然蛋白质含量提高,但面团强度不再受蛋白质含量影响,导致面筋质量下降[24-25]。Tahir 等研究结果认为,由于小麦品种的抗热害能力不同,品种间对热害的反应程度也存在差异[5,10,26-27]。对于大多数品种来说,都存在着温度对小麦品质影响的关键时期。高温胁迫对小麦品质的影响,不仅取决于品种间的抗(耐)热能力差异,在很大程度上还取决于灌浆期不同阶段所遇到的温度条件[24,16,22]。有些品种在小麦灌浆期即使仅受 3 d 的短期高温胁迫也会给籽粒的蛋白组分和小麦品质带来显著影响[24,28-29]。Irmak 等利用 Glu-D1 位点高分子麦谷蛋白亚基 5+10 和 2+12 近等基因系研究发现,在高温胁迫条件下高分子麦谷蛋白亚基 5+10 较 2+12 亚基耐热性好,并认为具有 5+10 高分子麦谷蛋白亚基的小麦品种和品系在温度变化较大时,品质较为稳定[2,30]。Castro 等研究结果认为,小麦品质在灌浆早期比中期和后期更容易受高温影响[7,14,31]。

3　耐高温育种的研究方法和内容

国内外在 20 世纪 90 年代就对小麦的抗热性开始较为系统的研究,并相继筛选出一批灌浆期抗(耐)热型新种质和不同生态类型小麦品种[8]。Anjum 等和 Zhao 等学者认为,为应对未来气候变化,不断提高小麦新品种灌浆期抗(耐)热能力,加大开发具有遗传多样性的抗(耐)热型小麦新种质研究极为重要[1,32-36]。在品种和种质抗热性筛选方法上,田间筛选热胁迫后耐热性的基因型仍是目前最经济有效的选择方法。在田间小麦灌浆期抗(耐)热选择标准上,Tyagi 等和 Singha 等认为,热胁迫条件下的籽粒重量是衡量品种抗热性选择的重要标准[37-38]。Dias 等则认为更高的灌浆速率和粒重潜力有利于品种耐热性的提高[39]。Tewolde 等通过田间记录温度的方法分析了 16 个基因型 2 a 的产量结果,认为早抽穗能够延长灌浆时间和避开灌浆早期高温,是耐热型小麦品种必备的性状[40]。近年来,一些分子辅助育种方法已被广泛应用于小麦抗(耐)热性筛选。Barnabas 等通过基因工程的方法已把个别抗热基因引入小麦品种之中[41]。Mason 等开发出的粒重,粒数,光合特性,灌浆速率,开花期及抗早衰等与抗热基因有关的 QTL,已被用于鉴定在灌浆期小麦耐热能力研究方面[42-45]。

4　结论

综上所述,小麦灌浆期温度变化与小麦品种品质潜力表达程度关系十分密切。当灌浆期遇到适度高温条件时,可使小麦品种蛋白质和湿面筋含量显著增高,面粉加工品质得到明显改善。当灌浆期遇到大于 30℃条件形成高温胁迫时,虽然小麦品种籽粒蛋白质含量有所提高,但因醇溶蛋白属热极蛋白,醇溶蛋白含量相对增加,不溶性谷蛋白聚合体含量相对降低,导致面筋的醇溶蛋白与麦谷蛋白的比率明显失调,进而使面团强度大幅度下降。小麦品种间抗高温胁迫能力不仅影响其品质潜力表达程度,而且与品质稳定性密切相关。上述研究结果对于小麦品质育种,特别是对于优质强筋小麦育种具有一定参考价值。至于高温和干旱是否会同步影响优质强筋小麦品种的品质潜力表达程度及光周期通过后小麦品种间的感温特性差异,是否与小麦品质稳定性存在密切相关等问题,还有待于进一步研究。

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Effect of Post-anthesis Heat Stress on Grain Protein Accumulation and Quality Traits for Wheat

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Abstract: High temperature are common in many of wheat growing areas and can be a significant factor in reducing yield and quality of wheat. In order to investigate the major cause for effect of heat stress on wheat quality, the impact of heat stress during grain-filling stages on fractional protein accumulation and quality was reviewed. In general, grain fractional protein content increased at elevated temperatures. When daily mean temperature was up to 30℃ during grain filling the dough strength was improved, and that as temperature increased above 30℃, the dough strength decreased. Furthermore, breeding strategies for improving heat stress tolerance in wheat were suggested, so as to provide useful information for breeding programmes and enhance the wheat quality.

Keywords: wheat; post-anthesis heat stress; grain protein accumulation; quality

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