The Specific Characteristics of Wheat With Polymorphic Canopy Temperature

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Abstract: Studies show that there exists a difference of canopy temperature (plant temperature) among different wheat genotypes in locations characterized by the completely identical climatic, soil and cultural conditions of any agro-ecological regions. Wheat varieties whose canopy temperatures are close to or consistently lower than that of check variety, being the dominant one in the region for a long time during kernel filling and maturing period are named as cold-type wheat; while wheat varieties whose canopy temperature are consistently higher than that of check variety are named as warm-type wheat. Some important characteristics of cold-type wheat are distinctly different from and superior to those of warm-type wheat. The differences of canopy temperature and biological characteristics between cold-type wheat and warm-type wheat are significant and they all show clear monomorphism. Wheat materials and most cultivars are different from cold-type wheat and warm-type wheat and they show strikingly polymorphism in canopy temperature, that is to say, there are canopy temperature fluctuation, consistently lower canopy temperature like cold-type wheat and consistently higher canopy temperature like warm-type wheat in different years. The polymorphism of canopy temperature goes well with the polymorphism of other important characteristics, such as leaf functional duration, transpiration rate, net photosynthetic rate and kernel plumpness index, etc. The state closely relates to the environmental conditions especially weather conditions, and not occurs stochastically. The environmental conditions can be evaluated by environmental index. Environmental index for kernel filling and maturing period in one year can be estimated by the mean 1000-kernel weights of the wheat materials used in the trials every year, and the environmental conditions...
are measured in 5 levels according to the variability of the environmental index. The frequencies of leaf functional duration, depauperation of transpiration rate, depauperation of net photosynthetic rate, and kernel plumpness index of wheat materials and most cultivars above-mentioned close to those of cold-type wheat, were 71%, 67%, 67% and 46% respectively, in a production year with good weather conditions and high environmental index; while in a production year with very poor weather conditions and low environmental index, the frequencies declined greatly to only 46%, 37%, 16% and 19%, respectively. On the contrary, the frequencies of above-mentioned traits of the same wheat materials close to those of warm-type wheat were significantly lower than those of the materials close to those of cold-type wheat in a production year with advantageous weather conditions (11%, 33%, 33% and 15%), while in a production year with very poor weather conditions, the frequencies rose greatly to 40%, 63%, 84% and 48%, respectively. That is to say, characteristics of wheat materials and most cultivars tend to those of cold-type wheat with strong metabolic functions under advantageous environmental conditions and tend to those of warm-type wheat with weak metabolic functions under very poor environmental conditions. The obvious variations of characters of wheat may be the most important biological reason resulting in the strong fluctuation of the yield of most wheat cultivars with weather variations for a long time. To improve wheat temperature types may be an important approach to obtain high and stable yield, that is to say, breeding cold-type wheat varieties in batches gradually and replacing old wheat cultivars, which vary intensely in characters and are widely adopted in wheat production, and making canopy temperature and characteristics of all wheat varieties to get typical characteristics of cold-type wheat. A great lot of work must be done in order to achieve this.

**Key words:** wheat; environmental conditions; characters; polymorphism

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1984 [1,2] Z. S. Wang et al. studied the characteristics of crowns temperature in wheat species and found that the temperatures of crowns of wheat cultivars and species were significantly different. In 1990s, [3,4], 1990s, 1980s, etc., [5,6] investigated the characteristics of crowns temperature in wheat species and cultivars, and found that the temperatures of crowns of wheat cultivars and species were significantly different. In 1990s, [7,8], 1990s, 1980s, etc., [9,10] investigated the characteristics of crowns temperature in wheat species and cultivars, and found that the temperatures of crowns of wheat cultivars and species were significantly different. In 1990s, [11,12], 1990s, 1980s, etc., [13,14] investigated the characteristics of crowns temperature in wheat species and cultivars, and found that the temperatures of crowns of wheat cultivars and species were significantly different. In 1990s, [15,16], 1990s, 1980s, etc., [17,18] investigated the characteristics of crowns temperature in wheat species and cultivars, and found that the temperatures of crowns of wheat cultivars and species were significantly different.
观测记载
对参试材料的生长发育状况进行了观测记载，尤其对功能叶的功能期，蒸腾速率，净光合速率和籽粒的充实状况进行了长期测定。叶片蒸腾速率和净光合速率用型号光合测定仪测定，籽粒饱满指数则用容量瓶注水法分别测得鲜粒最大体积和成熟晒干籽粒体积，然后计算求得。同时，还对参试材料的冠层温度进行了长期系统观测，观测时间为晴天的10:00～15:00，各材料冠层温度差异最明显时为主按农田小气候观测的对称法进行。所用仪器为型号红外测温仪，该仪器的分辨率为0.06%，测量精度为常温7.06%，响应时间为1/9秒，视场角2:30。上述各种测定均以对籽粒形成及充实有关键意义的灌浆成熟期为重，因而下文分析亦主要围绕这一时期进行。

结果与分析
冠层温度的态性
据1996～1999年资料，绘出灌浆成熟期间冠层温度依日序变化图，所谓日序指观测日的顺序，每相邻两次观测相隔8日左右。冷型，暖型和第一类小麦分别选用具代表性的和商对照品种是小偃*号。绘图时，小偃*号为基准，首先绘出穿越温差轴，并与日序轴平行的基准线，然后依日序将各种小麦材料与对照相比的冠层温差点落于图上。图2.1灌浆成熟期间冠层温度的变化。

图2.1

Fig. 1 Variation of canopy temperature during milk-filling

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后者则一律偏高！从这个意义上说，它们的温度状态受着温度基准线的严格约束。而第2类小麦则大相径庭！不但有冷型态，且还出现了对温度基准线向上向下的明显穿越！其变化的多样性是冷型和暖型小麦难望其项背的！充分显示了其多态性的特点。更有意思的是，这种多态性的出现并不随意！而是受着环境条件的显著影响！即当环境优良时，第2类小麦表现为冷型小麦温度特征的比例明显升高！当环境恶劣时，表现为暖型小麦温度特征的比例则显著上升！出现了在两极冷型和暖型小麦温度状态间的摆动！据研究知，冠层温度是环境条件和小麦本身生物学特性相结合的产物！是植株内所进行复杂代谢过程的反映！因而，第2类小麦温度的多态性应在其它一些重要性状上留有印迹。下面就此问题进行较深入的分析！

一些重要性状的变化下面的分析采用了！2003年前述15个冷型小麦、15个暖型小麦和15个第2类小麦共10个试验的数据！环境的优劣用环境指数表示！本试验是在一稳定地点连续多年进行的！土壤肥力和栽培措施基本相同！但天气条件变化很大！一般年优年和恶劣年交替出现！因而所谓环境的变化即主要指天气条件的变化！这里用每年参试材料千粒重的平均数作为该年灌浆成熟期的环境指数！并依据当地的气候特点，界定1环境指数变率<45.63为一般年，环境指数变率<45.63为优年，环境指数变率>45.63为很优年，环境指数变率>45.63为劣年，环境指数变率>45.63为很劣年。前两年的环境指数是近来最高的，分别为一般年环境指数变率为60>45，很优年环境指数变率为23>45。其环境条件的特点是小麦生长前期降水正常，而灌浆期间日照异常充分，后期综合生长条件甚优。前年的环境指数很低，其前后的等级是劣年环境指数变率为60>45，很劣年环境指数变率为23>45。其环境条件的特点是灌浆成熟期间阴雨连绵，低温多湿，寡照，使灌浆成熟大受影响。下面的分析就以2003年作为典型环境优良年，2004年作为典型环境恶劣年展开。

叶片功能期 小麦灌浆成熟期间，保持功能叶片较长的功能期一向受到人们的重视！它是叶源活力较强的重要标志。这里用开花至叶片枯亡持续日数与开花至籽粒成熟持续日数的百分比表示！比值大者活力好，持续时间长，否则活力差，持续时间短。图2，图3反映了具代表性的第2类小麦材料在环境优良年和环境恶劣年旗叶及倒2叶和倒3叶的功能期状态。
再看第2类小麦中的商
优良年时，其叶片功能叶的功能期明显位于暖型小麦变化区上方，而在恶劣年不但旗叶跌入暖型小麦变化区，且倒叶和倒叶比暖型区降低得更低，出现了叶片功能期随年型的明显波动。据对前述5个第2类小麦材料统计，优良年时，叶片功能叶的平均加权功能期达到冷型小麦水平的品次（品种次数）高达*#*%，而恶劣年则大幅降至#-%，和暖型小麦水平相同者优良年仅为##%，恶劣年则猛升至#。由此看出，第2类小麦的叶片功能期存在"种状态，即冷型态/暖型态和介于冷暖之间的中间态，且随环境指数的变化在冷型小麦和暖型小麦的叶片功能期这两极间明显摆动，即环境好时趋向于冷型小麦，环境差时趋向于暖型小麦。

叶片蒸腾速率的衰减。蒸腾是植物体散失水分的一种重要方式，不但和碳代谢/氮代谢/活性氧代谢等多种代谢过程紧密相连，且是造成冠层温度高低的直接原因之一。即蒸腾持续时间长且较强时，有利于冠层变冷，反之则有利于冠层变暖。在灌浆成熟期间，各种类型小麦的蒸腾速率均随时间推移而逐渐减弱，其中冷型小麦蒸腾持续时间最长且减弱慢，而暖型小麦则与此相反，不但持续时间较短且减弱较为迅速。一般来说，从灌浆结实的中后期起，其蒸腾速率就低于冷型小麦，有时甚至从开花期起就比之较弱，一直持续到成熟，这些统列入衰减迅速之列。

第2类小麦的蒸腾状况用旗叶/倒叶和倒叶蒸腾速率的加权平均值说明之。从图看出，在环境优良年，蒸腾速率的变化与冷型小麦相同者的频率占到第2类小麦试验品次的67%，而衰减迅速与暖型小麦相同者的频率明显较低，为33%。而在环境恶劣年，与冷型小麦相同者的频率大幅降至16%，而衰减迅速与暖型小麦相同者的频率则很快升至84%，较之蒸腾速率不同年型的对比还要强烈。

由上述分析可知，第2类小麦在净光合速率的衰减上亦有多种状态，且随环境条件优劣年的交替出现了在冷型和暖型小麦净光合状态之间的明显摆动，这可能是长期以来生产上所用大多数品种因天气转换而使产量大幅涨落的最重要的生物学原因。
籽粒饱满指数
籽粒饱满指数指小麦成熟时籽粒晒干体积与籽粒最大鲜体积的百分比值，它反映了籽粒被充实的饱满程度，是小麦植株体内所进行的一切生态生理过程的最后落脚点。同样，第（0）类小麦在此性状上亦有自身的特点。图（9）显示在环境优良年和恶劣年，第（0）类小麦的籽粒饱满指数总呈现多种状态，即饱满指数较高的冷型态，饱满指数较低的暖型态，以及介于两者之间的中型态。且随年型的更迭，籽粒饱满指数的升降十分明显。在环境优良年，籽粒较饱满为冷型态的频率是C）D），而籽粒饱满度差为暖型态者是E）F）DG。在环境恶劣年，籽粒较饱满为冷型态的频率显著下降至E）H）D），而籽粒饱满度差为暖型态者则大幅上升至C）I）D）。同样出现了在冷型和暖型小麦籽粒饱满状态间的明显摆动。这往往成为产量结构失衡从而导致产量起伏的主因。

讨论
通过上述分析可知，自然界除了存在冠层温度持续较低，代谢功能较好的冷型小麦和冠层温度持续较高，代谢功能较差的暖型小麦外，还存在一类多态性小麦，其性状具有冷型态和暖型态，且这些状态和环境条件有着紧密联系，即当环境优良时，它们的一些重要性状趋向于冷型态，当环境恶劣时，它们的一些重要性状则趋向于暖型态。这类小麦依年型的更迭在两个极端冷型小麦和暖型小麦的状态间进行着有规律的摆动，因而可以有理由认为，在浩如烟海的小麦材料中，一种有别于冷型和暖型小麦的第（0）种类型正被识别和分离出来。为了研究的方便，作者特称这类小麦为中间型小麦。据观察，一般育种材料和生产上使用的大多数品种都属于中间型小麦，冷型小麦很少。长期以来小麦产量波动较大，尤其一些高产品种其高产的重演性较低，这成为争取小麦产量稳步上升的瓶颈。而中间型小麦性状多态性的揭示，似乎从互作角度触及到问题的生物学本质，因而欲使这一困扰人们的瓶颈问题得到较好解决，转换小麦类型可能是条重要途径，那就是通过若干年的努力，使目前处于主导地位的中间型小麦的比重逐渐下降，并代之以冷型小麦，逐步实现品种冷性化。这是需要做大量工作的。可喜的是，带有强烈冷性化目的的冷型小麦的选育已取得实质性进展，和自然环境可以较为和谐相处的这种温度型正越来越受到人们的重视。因而其前景是令人鼓舞的。

参考文献