小麦胚芽鞘与耐深播抗旱研究进展

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摘 要:根据作者多年试验观察,综述澳美欧亚非 30 多个国家相关研究可知,胚芽鞘长、细、硬、快的小麦品种耐深播、抗旱、立苗好。小麦的"地中茎"由上胚轴组织派生且位于胚芽鞘基之上。小麦无中胚轴、无"根茎"。实证双胚苗的第二胚芽鞘自然开裂,并图释深播地中"拔节"现象值得研究者关注。小麦品种间胚芽鞘遗传长度变幅在 1.5~18.0 cm,胚芽鞘长度的生理变异及环境变异小于品种间变异。多数矮秆基因都缩短鞘长,但鞘长基因加性遗传,有育成矮秆长鞘、出苗力强、苗期抗旱、长势壮的新品种的报道。长胚芽鞘品种的胚较大,这涉及到小麦脂肪优质育种的问题。建议:(1)尽快摸清中国的小麦长鞘品种资源,协商制定中国小麦胚芽鞘长与鞘色的描述标准;(2)加大常规育种中 F2 代的播量并加大播深,以便早代汰除出苗力差的个体;(3)强制描述小麦品种的鞘长、鞘色及批售种子的鞘长。

关键词:小麦;胚芽鞘;中胚轴;地中茎;矮秆;抗旱性
中图分类号:S512.1 **文献标识码**:A **文章编号**:1000-7601(2012)03-0051-07

国外实证,小麦出苗差苗势弱所造成的减产量往往大于优种本身的增产量[1]。黄淮麦区农谚也有"有苗收一半,没苗不见面"的说法。由于秋播干旱表土缺墒以及玉米秸秆还田表土攮虚等,造成黄淮麦田缺苗断垄、花脸田、参差不齐小老苗问题严重,导致地力和品种生产力都不能充分实现。耕作对策不外乎是:耙耱保墒、碾压提墒、浇水增墒、提高整地质量;"有钱买籽,没钱买苗"加大播量;"有墒不等时,过时不等墒"提前播期;或干籽寄种或湿沟或浸种;或双耧对播;或深开沟剷去表层干土赶墒播种至离地表 20 cm 深处[2],等等。这些措施既加大工、能、物耗,也不能一站式解决苗齐苗全的问题。世界其他三大旱地麦区(东南澳麦区、北美大平原麦区、地中海盆地麦区)[3]的小麦育种家们,选育长胚芽鞘小麦新品种赶墒深种,一播苗全、齐、匀、壮,不但省种子节成本、增产、环境友好,还有利于减少表土除草剂的影响[4],并抵消种衣剂中杀菌剂对胚芽鞘的抑制作用[5]。与此同时还开发出了小麦脂肪优质育种新领域。本文综述有关研究进展,希望有裨益于黄淮麦区的小麦抗旱耐深播育种研究。

1 胚芽鞘长、细、硬、快的品种耐深播、立苗好

小麦种子发芽历经吸胀、复苏、萌动三个阶段,幼苗出土靠胚芽鞘开道、地中茎助推、第 1 叶顶土三股力量。小麦唯第 1 叶顶钝圆(图 1),应是进化过程中顶土选择的结果。

注 Note:下胚轴生 Produced by the hypocotyl; 上胚轴生 Produced by the epicotyl; 胚芽鞘 Coleoptile; 地中茎 Coleoptile internode; 第 1 叶顶钝圆 Leaf 1 has a blunt tip; 第 2 叶顶渐尖 Leaf 2 has a pointed tip.

图 1 小麦幼苗
Fig.1 Wheat seedling

矮秆短鞘品种出苗差,要选育矮秆长鞘品种[6]。胚芽鞘长度及伸长速率与出苗力密切相关[7-8]。出苗率与鞘长显著相关($r^2=0.71$, $P<0.004$),胚芽鞘长大于 10 cm 的品种都耐深播、出苗好,高秆长鞘第 1 叶长 20.7 cm 的老品种 Moro,在北美大平原旱地麦田因出苗最好,收成稳居前茅而持续 30 多年不衰[2]。长胚芽鞘有利于干旱高温情况下深播出苗,Rht8 矮秆可长鞘最大播深达 12 cm[9]。5 个品种中最耐深播品种 Hongwangmai 的胚芽鞘最长、鞘尖横截面积最小,幼苗顶土力与胚芽鞘长显著正相关($r=0.974, P<0.01$),与鞘尖横截面积显著负相关($r=-0.929, P<0.05$)[10]。

收稿日期:2012-02-25
基金项目:农业行业专项"黄淮海小麦抗旱抗干热风生产技术研究与示范——黄淮小麦决策支持系统"(nyhyzx07-002-(3-2))
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播深 8 cm 时耐深播乙烯处理品种 Hongwangmai 的地中茎(该文叫第 1 节间)达最长；播深 6 cm 时“农林 63”的地中茎达最长；胚芽鞘长度与地中茎长度的相关系数在 0.768 ~ 0.593 之间；深播和乙烯处理刺激地中茎伸长；小麦对乙烯反应力是可遗传的[11]。潘幸来等沙培试验 3 年 30 个品种，最大地中茎长多近似等于其最大胚芽鞘长，唯“晋麦 61”的最大地中茎长大于其最大胚芽鞘长约 1 cm，而“舜麦 1718”的最大地中茎长小于其最大胚芽鞘长约0.5 cm。

综上可见，胚芽鞘长、细尖、硬度好、伸长速度快，地中茎长，第 1 叶长的品种，耐深播、出苗力强、立苗好。

2 小麦胚芽鞘原在上胚轴，地中茎不是根茎，也不宜称第 1 节间

为叙述方便，我们用图 2 标示小麦胚轴的划分。

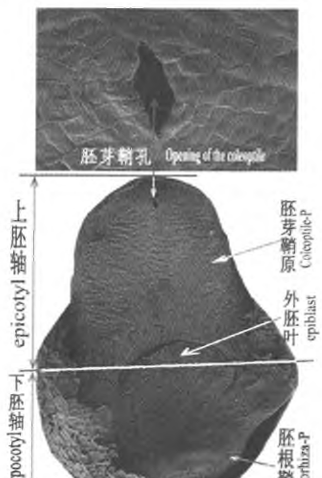


图 2 小麦胚轴的分部

Fig.2 Parts of the wheat embryo axis

小麦下胚轴细胞极性全向下，而且都是专能或单能细胞，只分化胚根鞘和种子根，无一能自然分化成其他器官。

小麦上胚轴细胞极性全向上，其中有专能细胞群、多能细胞群、全能细胞群。

小麦苗自胚芽鞘基以上为上胚轴生、胚根鞘基以下为下胚轴生(图 1)；上下胚轴的界面间，可能夹有水平极性的细胞层，偶尔从中可生出水平走向的轴面根[12]，但该夹层却从不像玉米的中胚轴那样伸长成数厘米(图 3)甚至 30 ~ 40 cm 长[13]的介于胚芽鞘与胚根鞘之间的“根茎”，所以说小麦没有“中胚轴”。

注 Note：下胚轴生 Produced by the hypocotyl；种子根 Primary roots；中胚轴生 Produced by the mesocotyl；根茎 Rhizome；上胚轴生 Produced by the epicotyl；胚芽鞘 Coleoptile；第 1 叶顶钝圆 Leaf 1 has a blunt tip；第 2 叶顶渐尖 Leaf 2 has a pointed tip.

图 3 玉米幼苗

Fig.3 Corn seedling

比较图 1 和图 3 明显可见，玉米的“根茎”是由中胚轴生成的，所以位于胚芽鞘基之下；小麦的“地中茎”则是由上胚轴组织生成的，所以位于胚芽鞘基之上。

切取 2 ~ 5 d 幼苗的胚芽鞘 MS 培养基培养 6 周形成愈伤组织，再转培 6 周获得脆性结节组织，再转培后获得了再生麦苗[14]。但在自然条件下，胚芽鞘细胞无一能分化成其他器官。

适播麦苗的胚芽鞘基与“分蘖节(crown)”之间可长出数厘米长的“胚芽鞘节间(coleoptile internode)”通常称之为“地中茎”(图 1)，也有叫“冠下节间(sub-crown internode)[15]”或“第 1 节间(the first internode)[11]的。

小麦的“地中茎”发生于胚芽鞘基之上，无疑源自上胚轴且全为单能细胞，在其基底与胚芽鞘基之间，常有可分化胚芽鞘分蘖的全能细胞组织，所以更类似茎基的遗传生理功能，又因其只长在土壤中，故称“地中茎”名副其实。称“冠下节间[15]”不甚通俗，不如称“胚芽鞘节间(coleoptile internode)”更确切也更符合发生学事实及叶序学理论。播种过浅就没有“地中茎”，所以称“第 1 节间[11]”容易混乱。称“中胚轴(mesocotyl)”显然误解。像图 4[16]把小麦的“地中茎”称作“根茎(rhizome)”并把胚芽鞘画在“根茎”之上，显然与图 3 玉米的情形相混淆了，胚芽鞘应在 x 与种籽的连接处，不应定义 x 为 rhizome(根茎)。文献中漏标胚芽鞘的麦苗图示亦屡见不鲜。

3 小麦胚芽鞘的导向及保护作用

小麦胚芽鞘是套筒状保护鞘，两侧无缝各有一组维管束，鞘顶侧胎生有孔(图 2)供第 1 叶穿出。双胚芽苗的第 2 胚芽鞘自然开裂形似卷筒(图 5)。

胚芽鞘顶部细胞中含吲哚乙酸而有强向光性，Mitchell 等把 114 个品种倒种强迫向地，胚芽鞘仍会自转向上生长[17]。胚芽鞘中的重力因子垂直于其纵轴，自向性克服向地性而使胚芽鞘伸直向上[18]。这与黄淮麦农说的“麦籽会翻身”相吻合。

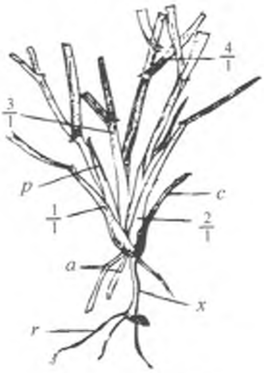


图 4　胚芽鞘 *c*

Fig.4　Coleoptile *c*

套筒鞘 a The 1st coleoptile with no seam; 卷筒鞘 b The 2nd coleoptile splits on one side

图 5　双胚苗第 2 胚芽鞘自然开裂

Fig.5　The 2nd coleoptile of the seed with double plumules splits

小麦胚芽鞘较硬而脆[19]，这可能与其顶土力有关。品种 Nesma149 的胚芽鞘的最大顶土力达 30 g 左右，阻力小于 25 g 时，出苗率达 100%，种床土块直径不超过 30 mm 为宜[20]。

小麦胚芽鞘表皮细胞层中植物血凝素(lectin)含量高达 1.9 ng/鞘，约占胚中血凝素总量的 41%[21]。小麦胚芽鞘并不合成植物血凝素，但 ABA 能促进植物血凝素在胚芽鞘细胞中积累[22]。从小麦胚芽鞘中纯化出了可溶性酸转化酶，是一种单聚体糖蛋白，分子量 50 kD[23]。麦胚蛋白中能裂解溶壁微球菌的水解酶 W1A 主要分布在胚和胚芽鞘的细胞壁中[24]。小麦种子中的防卫蛋白主要集中在胚和胚芽鞘中[25]。小麦胚芽鞘还常用于药物化验[26]。

4　小麦胚芽鞘长及鞘色的遗传

英国 Wright 等用国王 2 号小麦种子水浸 2 h 后锌盘沙培 25±0.5℃120 h，每 6 h 测样发现：每个胚芽鞘的细胞总数从最初的约 36 000 个增至约 125 000个即停；鞘外表皮细胞和鞘顶部细胞只膨大不分裂；皮层及维管束中核大质浓的细胞分裂 1～2 次扩增鞘细胞数约 3 倍；60 h 鞘长 17 mm 时鞘细胞即终止分裂；96 h 胚芽鞘即达最大长度的 95%；单细胞体积均增 52 倍；鞘均最大鲜重 65 mg；鞘蛋白氮含量比初始值增 8.6 倍；鞘酸解 N 含量比初始值增 60 倍[27]。

适播小麦胚芽鞘生长可分为 3 个阶段：播种 0～30 h 为细胞膨胀期；30～60 h 为细胞膨大+分裂期；60～120 h 为细胞膨大期[28]。

有说成熟种子的胚芽鞘细胞核分裂已全部完成，萌发生长期间只有膨大生长及部分细胞的质分裂。这需要核实是否双核或生长期间鞘 DNA 是否加倍等方可定论。但毫无疑问，胚芽鞘的细胞数目是遗传决定的，同品种同条件适深及更深播种，胚芽鞘的最大长度基本一致，这就是胚芽鞘的遗传长度。

Hussar/Konsul A//Lut.96-6 组合的品系中胚芽鞘最短的仅 1.5 cm[1]；Altay-2000 的胚芽鞘长仅2.50 cm[29]；Bai 等在美国比较 130 个小麦品种的胚芽鞘长在 4.4～11.4 cm 间，Pioneer 最短为 4.4 cm，LongXi18 最长为 11.4 cm[30]。小样本品种(系)的胚芽鞘长度变化范围为 9.4～14.2 cm，直径变化范围为 1.56～1.84 mm[9,31]；旱地品种胚芽鞘最长达 15 cm[2]；CSIRO PI 报告有新育成鞘长 18 cm 的抗旱节水小麦新品种(个人交流)。

矮秆品种胚芽鞘一般都短。立陶宛的小麦新品种(系)的胚芽鞘长度多在 5～7 cm 之间[1]。绝大多数矮秆半矮秆品种的胚芽鞘长度都在 5.0～8.0 cm 之间，半矮秆品种的胚芽鞘长度比高秆品种的短 30%～49%[7]。

胚芽鞘色有淡白、紫、红三种。绝大多数品种的胚芽鞘是淡白色。鞘色主要取决于鞘细胞中花青素的种类和数量。小麦胚芽鞘花青素由位于 7A,7B,7D 短臂上的 *Rc*1, *Rc*2 和 *Rc*3 控制[32]。粒色基因 *R* 和鞘色基因 *Rc* 都上调黄酮类生物合成基因[33]。3 个 *Rc* 基因可能有一定的地理分布[34]。*T. monococcum* 的鞘色受单基因控制且不与颖色基因连锁[35]。

5　生理及环境因素对胚芽鞘长与鞘色的影响

同品种的种籽的胚芽鞘长也因千粒重、成熟度等生理因素而稍有差异，称此为生理长度。同一品

种粒重相差 1 mg 鞘长相差 0.37 mm[36]。Cook 和 Oxley 品种的温室产种子比大田产种子的胚芽鞘更长一些,其他品种的温室产种子与大田产种子的胚芽鞘长无甚差异[37]。小麦胚芽鞘细胞壁中的阿魏酸和二阿魏酸及基部细胞中的纤维素均与细胞壁的伸展有关[38]。

同品种同生理状态的种籽的胚芽鞘长也因多种环境因素的影响而有所变异,称此为环境长度。浅播的胚芽鞘一出土见光即停止伸长,荧光照条件下比全暗条件下生长的麦苗的胚芽鞘缩短 50% 左右[39]。红光对初生胚芽鞘的生长先是通身性抑制而后才是分区性抑制[40]。矮壮素、甲基丙烯酰氧乙基三甲基氯化铵、氯化乙酰胆碱等 3 种氯化物加红光脉冲都抑制胚芽鞘长[41]。对暗中生长的麦根施用 60 mg 的 PEG 后,即显著降低胚芽鞘的伸长[38]。激光辐照种子可使品种间的鞘长差异加大[42]。

胚芽鞘开始萌动需要 35℃ 日积温,1℃ 温度下即能伸长。冬春性品种在 8℃ ~ 25℃ 范围内,鞘长基本不受温度影响,在 5℃ ~ 25℃ 间,鞘伸长率依温度增高而线性增加[43]。8 个品种控温 15℃ 条件下平均鞘长 10.8 cm,变幅 8.7 ~ 14.5 cm;控温 35℃ 条件下平均鞘长仅 3.1 cm,变幅缩至 2.7 ~ 3.6 cm;平均每增高 2.6℃ 鞘长减少 1 cm;高秆品种的最大鞘长的适温范围宽,矮秆品种的最大鞘长的适温范围窄[36]。11℃ ~ 15℃ 间胚芽鞘更长,23℃ 下胚芽鞘缩短[9]。早播地温高有缩短胚芽鞘长的趋势[44]。

发芽种子失水后再复水,鞘长缩减 17% ~ 58%[45-47]。

种子处理剂中的一些化合物能进入胚芽鞘中[48]。种衣剂一般不影响发芽,但却显著减少胚芽鞘长小于 5 cm 的品种的出苗率[49]。萎锈灵 + 福美双, burel + propolis,双胍辛胺,恶醚唑,苯醚甲环唑等都影响胚芽鞘生长[50]。播深 4.0 ~ 7.5 cm,每米种床施 1 ~ 2 g 尿素的发芽迟缓、鞘长缩短、出苗减少;每公斤种子拌 0.025 g 和 0.1 g 粉唑醇的鞘长缩短、出苗减少;镇压种子覆土提高出苗率 20% ~ 37%[51]。用 5 g 萎锈灵拌种 1 kg 小麦种子,澳大利亚的 Banks 品种在 15℃ ~ 30℃ 范围内,胚芽鞘皆显著缩短[52]。用三唑酮 - 林丹处理 3 个小麦品种的种子,胚芽鞘皆缩短、出苗率都降低[53-54]。

一些分解或提取的有机物也影响胚芽鞘的生长。麦秸提取物影响玉米胚芽鞘长 21% ~ 30%[55]。鄂梨叶提取物抑制小麦胚芽鞘生长[56]。南澳 6 个油菜品种的根茬地缩减小麦胚芽鞘长,降低小麦根生长[57]。麦秸中的纤维素和半纤维素是微生物活动生成挥发性脂肪酸尤其是醋酸的底物,挥发性脂肪酸及醋酸对下茬作物种子发芽有害[58]。

深播和乙烯都刺激地中茎的伸长[11]。4 cm 播深加 0.76 kPa 机械阻力时,所有品种鞘长均减少 18%;粒重大 1 倍的种子的鞘长仅增加 9%;在最小土壤阻力下选择长鞘性状有效[59]。

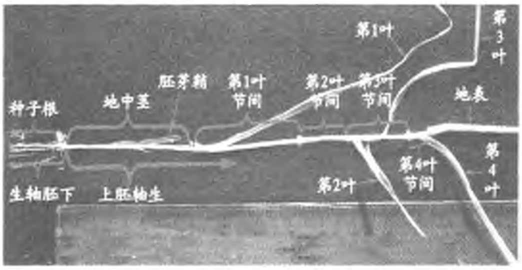
胚芽鞘长依盐度增高而缩短,0.3 mol/L Na_2CO_3 条件下即基本停长;胚芽鞘比根耐盐碱,0.08 mol/L Na_2CO_3 时,发芽小麦无根但胚芽鞘仍伸长[54]。

强光、低温、好营养一般多促进花青素合成,发芽种子生长在 1% NaCl 溶液中,鞘色会加重,红、紫鞘色的品种一般耐旱性好[33]。

6 地中茎长 1 cm 的麦苗的播深最适宜

Radford 用鞘长加粒重确定最佳播深[36]。种子公司推荐小麦品种播深以胚芽鞘刚出土为宜,短鞘品种在壤土中的最适播深为 5.2 cm,在粘土中的最适播深为 5.2 - 1.3 = 3.9 (cm),在沙土中的最适播深为 5.2 + 1.3 = 6.5(cm);中等长度胚芽鞘品种在壤土中的最适播深为 5.2 + 1.3 = 6.5(cm);长胚芽鞘品种在壤土中的最适播深为 5.2 + 2.5 = 7.7 (cm)[47]。矮秆品种适宜播深为 4 ~ 5 cm,播深 7.5 cm 的出苗率都低于 51%,播深 10 cm 的无一出苗;株高与鞘长的相关系数为 0.805[42]。

总而言之,适宜条件下,(1) 浅播的胚芽鞘一出土见光未及遗传长度即停止伸长,第一片叶从其顶侧裂口伸出,这或许有利于节省化能营养成本并及早光合自养,但浅播漂籽土湿发芽的却都是些叶片短小根系丛生的侏儒苗,个体不佳单株籽粒产量差;(2) 播深适宜时,胚芽鞘、地中茎均达到各自的遗传长度,叶蘖根皆按比例同伸,种子根与次生根之间有约 1 cm 的地中茎间隔,而不拥挤在一个土层,个体健壮单株籽粒产量高;(3) 播深比胚芽鞘长大 2.0 cm、3.0 cm、4.0 cm、5.0 cm、6.0 cm 时,出苗率一般分别降 30%、40%、50%、60%、70% 以上;(4) 播深大于鞘长 + 地中茎长时,大多都蜷芽土中自死,能出土苗的地中茎以上皆有第 1 叶节间或第 2 叶节间甚或第 3 叶节间伸长(图 6)。图 7[60] 依《作物栽培学》把这些地中节间标定为"RS = 上胚轴"显然失当。如何用春化理论解释这种幼苗在地中"拔节"的现象,亦有待学界关注。这样的苗子纤弱单薄、单株籽粒产量差。



下胚轴生 Produced by the hypocotyl; 种子根 Primary roots; 上胚轴生 Produced by the epicotyl; 胚芽鞘 Coleoptile; 地中茎 Coleoptile internode; 第 1 叶 Leaf 1; 第 1 叶节间 Leaf 1 internode; 第 2 叶 Leaf 2; 第 2 叶节间 Leaf 2 internode; 第 3 叶 Leaf 3; 第 3 叶节间 Leaf 3 internode; 第 4 叶 Leaf 4; 第 4 叶节间 Leaf 4 internode.

图 6　深播小麦苗地中拔节

Fig.6　Deep-sown wheat seedlings produce several internodes in soil

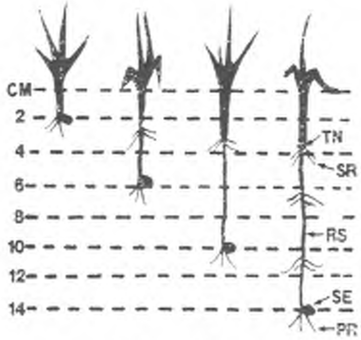


图6-1　种子(SE)不同播种深度下分蘖节(TN)的深度。PR. 初生根; RS. 上胚轴　SR. 次生根。(依《作物栽培学》[1]改绘)

图 7　RS 不是上胚轴

Fig.7　RS is not the bona fide hypocotyl

无论短鞘、中长鞘、长鞘品种,大田拔苗若见地中茎长 1 cm 多一些,即可认定播深适宜;无地中茎苗属播种偏浅;地中茎长超过 2 ~ 3 cm 的属播种偏深。生产实践中掌握 1 定 4 修正原则确定适宜播深:以品种、种子鞘长定播深,依土壤质地、播期早晚、种子处理剂、预计出苗天数而加以调整(调整幅度可参考本文 6 的经验参数)。

7　矮秆长鞘品种选育与优质脂肪育种

农家种是传统保持育种法育成的,在埃塞俄比亚,小麦撒播实际上是对出苗一致性的一种选择[61]。也有用热休克法筛选苗期耐热的小麦品种的[62]。

矮秆基因 *Rht*1、*Rht*2、*Rht*1 + 2、*Rht*3、*Rht*8 都缩减胚芽鞘长,而以 *Rht*3 最甚[63]。6 个组合的亲本与 F1 和 F2 群体中的胚芽鞘长与株高显著相关[64]。小麦胚芽鞘长加性遗传[65]。从保加利亚、罗马尼亚、南斯拉夫三国品种复交组合中选出的新品系 Sincron 的胚芽鞘细胞数目及长度都超过亲本,有可能选出带 *Rht*8 的长胚芽鞘品种[66]。罗马尼亚新品种中带 *Rht*1 且长胚芽鞘的出苗都好,带 *Rht*8 的胚芽鞘都长[67]。*Rht*13 在茎秆伸长后期才起作用,主要缩短穗轴和穗下节间,对胚芽鞘长影响不大[68]。

澳大利亚 CSRIO PI 已育成了矮秆长胚芽鞘、苗期长势强的旱地小麦新品种,胚占种子的 8%左右(个人交流。一般品种的胚只占种子的 2%左右),并已成功地将 DHA 基因转入拟南芥[69],以期再转入大麦、小麦而使麦胚油得到优化。

8　胚芽鞘遗传长度的测定方法

常用的检测小麦胚芽鞘长的方法有:挖苗法、斜坡梯度沙培法、基质暗箱法、培养皿法、铝/滤纸夹籽卷筒法等。培养皿法更适用于大批量品种系筛选鞘长:直径 30 ~ 50 mm 培养皿内垫 0.4 ~ 0.5 mm 厚的海绵上置 30 ~ 50 粒一致好种子,加 60℃ ~ 70℃水至淹没种子 5 min,换 20℃水至半淹种子,置 18℃ ± 0.5℃恒温暗箱始终保持海绵湿润 9 d 后取出,直立一把尺子,水平眼观最短、最长鞘苗数及鞘长众数平均即得该品种的遗传鞘长值,一批可检测 300 ~ 500 个品种。

9　讨论与建议

美国用中国的长鞘品种 LongXi18[29]、日本用中国的长鞘品种 Hongwangmai[11]做研究,澳大利亚用中国的 Jinghong 4 号选出了矮秆长鞘耐深播新品种(Richards,个人交流)。黄淮麦区十年九旱,历史上有撒播种麦传统,一定有不少耐深播农家品种。建议:(1) 各小麦品种资源单位全面检测自有品种资源,尽快推荐长鞘耐深播出苗力好的材料供各育种家利用;并协商制定中国小麦胚芽鞘长、鞘色的描述标准。(2) 各育种家可考虑加大 F2 播量到 3000 粒(常规 2000 粒左右)并加大播深,一次汰除出苗力差的个体,F3 以后各代皆可适度施加深播选择压;尽快引入长鞘资源配组;如有精力也可筛选本圃资源及后代的胚芽鞘长。(3) 品种管理、审定等单位应强制育种工作者描述其品种的胚芽鞘长及鞘色,强制商家明示其批售种子的胚芽鞘长供麦农参考。

秋播干旱、表土缺墒、玉米秸秆还田表土攮虚,是影响黄淮麦区旱地及水地小麦全苗壮苗的两大普

遍问题。借鉴国外经验,应予关注、支持培育长胚芽鞘耐深播抗旱以及优质脂肪的小麦新品种。

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Study on model of crop water requirement regulation and irrigation schedule based on *T-ET* function method

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Abstract: A study was carried out to develop irrigation schedule for alfalfa in Aksu as an example. In use of Penman-Monteith formula, *T-ET* functional model of crop irrigation schedule was established through the function of crop growing days and water requirement. The results show that, irrigation should be made 25 times annually with a total irrigation amount of 750 mm when the irrigation was designed as: using 32# spray nozzle, with a spray range of 20 m, flow rate of 4.71 m^3/h, effective control area of 315 m^2 and irrigation intensity of 14.95 mm/h. The water requirement regulation of alfalfa and the corresponding irrigation schedule can be obtained by using the model, which is practical way to make irrigation schedule and promote water use efficiency in certain regions.

Keywords: irrigation schedule; crop water requirement regulation; Penman – Monteith formula; alfalfa; sprinkler irrigation

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Wheat coleoptile and emergence vigor and drought-resistance

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Abstract: Sixty-nine research papers show that, wheat varieties with longer, thinner, stiffer and faster coleoptile, always give better seedling emergence vigor. Based on years' investigations, from the viewpoints of morphogenesis and cell behavior, the coleoptile internode of wheat is located above the coleoptile, not below the coleoptile. Both the coleoptile and the coleoptile internode are produced by the hypocotyl. While the rhizome of corn is below its coleoptile, it is produced by the mesocotyl. Pictures show that the second coleoptile of the shoot is naturally split, and several leaf internodes can occur in deep – sown conditions, and vernalization researchers should attach important to this phenomenon. The genetic length, physiological length and the environmental length of wheat coleoptile are summarized. Breeding wheat for fat quality is mentioned. Three suggestions are proposed for Chinese wheat workers.

Keywords: wheat; coleoptile; mesocotyl; coleoptile internode; dwarf stem; drought resistance