

甘肃省小麦地方品种春化、光周期基因 分布频率及冬春性分析

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摘要: 地方品种资源是小麦新品种选育的重要亲本来源, 充分应用其优异性状对于育种实践具有重要意义。本研究利用分子标记检测甘肃省种质库地方品种春化(*Vrn-A1*、*Vrn-B1*、*Vrn-D1*和*Vrn-B3*)和光周期(*Ppd-D1*)基因的等位变异。结果表明: (1) 445份地方品种共携带6种春化基因显性等位变异, 分布频率差异较大, 分别为*Vrn-A1a* (2.5%)、*Vrn-B1a* (11.0%)、*Vrn-B1b* (1.6%)、*Vrn-B1c* (0.5%)、*Vrn-D1* (67.4%)和*Vrn-B3* (0.5%); 在检测材料中光周期非敏感等位变异*Ppd-D1a*分布频率为17.8%。(2) 除*Vrn-B1a*+*Vrn-D1*外, 其余显性春化基因等位变异组合的材料全部分布在春麦区; 从春麦区到冬麦区, 春化基因显性等位变异分布频率呈降低趋势, 而隐性等位变异频率呈升高趋势; *Ppd-D1a*在甘肃省不同麦区均有分布, 且冬麦区分布频率远高于春麦区。陇东旱塬冬麦区分布频率最高(35.6%), 洮岷高寒春麦区分布频率最低(5.1%)。(3) 比较基于资源目录记载的冬春性和春化基因显性等位变异推断的冬春性的一致性, 发现春性和弱冬性品种的一致性较高, 冬性和强冬性品种的一致性较低, 从甘肃省春麦区到冬麦区, 一致性逐渐降低。(4) 筛选出83、119和82份地方品种, 可分别在春麦区(甘肃省中西部及洮岷高寒春麦区等)、冬季较为温暖的秋播冬麦区(陇南嘉陵江上游、天水南部渭河上游等)及较为寒冷的冬麦区(如平凉、庆阳的泾河流域及天水、定西的北部等)的育种中广泛应用。研究结果为现代小麦育种中发掘利用优异地方种质资源提供参考。

关键词: 小麦; 甘肃地方品种; 春化基因; 光周期基因; 等位变异; 冬春性

Distribution Frequency of Vernalization and Photoperiod Genes in Gansu Wheat Landraces and Winter Hardness Analysis

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Abstract: Landraces are important parent sources in wheat breeding, and play vital roles in the breeding progress via introgressing elite traits. Using allele-specific markers of wheat vernalization genes *Vrn-A1*, *Vrn-B1*, *Vrn-D1*, *Vrn-B3* and photoperiod gene *Ppd-D1*, this study detected their dominant allelic variations in 445 Gansu landraces, and analyzed the relationship with winter-spring growth habits. The results showed: (1) The frequencies of the dominant alleles at the four vernalization genes were 2.5% (*Vrn-A1a*), 11.0% (*Vrn-B1a*), 1.6% (*Vrn-B1b*), 0.5% (*Vrn-B1c*), 67.4% (*Vrn-D1*) and 0.5% (*Vrn-B3*), respectively, and the frequency of

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the photoperiod-insensitive *Ppd-D1a* allele was 17.8%. (2) Except for *Vrn-B1a* + *Vrn-D1*, different combinations of dominant alleles were detected in landraces collected from spring wheat regions. The frequency distribution of dominant vernalization alleles decreased gradually from spring wheat to winter wheat regions, whereas all recessive allele composition at *Vrn1* and *Vrn-B3* loci increased constantly. The *Ppd-D1a* was detected in Gansu landrace germplasm from different wheat regions, and its frequency in winter wheat region was much higher than that in spring wheat region. The highest frequency (35.6%) was observed in Longdong dry land winter wheat area, and the lowest (5.1%) was detected in Taomin high and cold spring wheat region. (3) Through comparing the genotyping results with the historic phenotype recorded from wheat resource catalogue of Gansu Landrace, a lower coincidence was observed in winter/strong winter landraces than that in spring/mild winter wheat, and the coincidence decreased gradually for the landraces from the spring wheat to winter wheat regions. (4) Eighty-three spring wheat, 119 mild winter wheat and 82 winter wheat were identified, which can be applied in spring wheat region (Central and western Gansu province, high and cold Taomin spring wheat area) and autumn-planting winter wheat regions with warmer (Longnan Jialing River Upstream and Upper Wei River in Southern Tianshui) and colder winter region (Pingliang, Qingyang Jing River basin, North of Dingxi and Tianshui), respectively. In conclusion, this study provided a reference for mining excellent traits of landrace varieties in modern wheat breeding.

Key words: wheat; Gansu landrace variety; vernalization gene; photoperiod gene; allelic variation; winter-spring characteristic

小麦是我国主要粮食作物,随着气候和环境的变化,小麦品种需不断更新换代。优异种质资源是选育丰产、广适、优良品种的物质基础。现代育种的种质资源极度狭窄,亟需从近缘种和地方品种中挖掘优异种质,以拓展育种亲本基因种类,为丰产抗病广适新品种培育奠定基础。提高产量始终是国内小麦育种的重要目标。除产量潜力外,产量及其稳定性还受适应性、抗病性及抗寒性等影响。微调适应性相关基因对提升小麦产量潜力至关重要^[1],适应性主要由春化、光周期和早熟基因决定^[2-3]。研究春化、光周期基因等位变异组成及其效应对小麦引种、育种及生产布局具有重要意义。国内外在春化、光周期基因定位、效应和分子标记开发等领域开展了广泛研究,每个小麦基因组至少包含 *Vrn-1*、*Vrn-2* 和 *Vrn-3* (*Vrn-B3* 为主要基因) 等春化基因位点^[4]。春性由一个或几个 *Vrn-1* 位点 (*Vrn-A1*、*Vrn-B1*、*Vrn-D1*) 显性等位基因控制,同源基因分别位于染色体 5A、5B、5D 长臂^[5-6]。*Vrn-3* 位点的显性等位变异减少春化需求^[6],*Vrn-2* 位点的隐性等位变异加速开花^[7-8]。*Vrn-B3* 的部分同源基因位于 7A、7B 和 7D 染色体^[9]。*Vrn-1*、*Vrn-B3* 基因已被克隆,其分子标记也已开发^[6, 9-11],并广泛用于品种检测^[12-14]。*Vrn1* 是小麦抗寒性的关键性遗传调控位点之一,显性基因 *Vrn1* 的存在会显著降低品种的抗寒性,具有 2 个或 3 个 *Vrn1* 显性基因的品种一般抗寒

性都很弱,携带对应隐性等位变异的材料对低温较迟钝,而 3 个位点均为隐性基因的品种具有强的抗寒性^[15-17]。光周期基因包括 *Ppd-D1* (*Ppd1*)、*Ppd-B1* (*Ppd2*) 和 *Ppd-A1* (*Ppd3*), 分别位于染色体 2D、2B 和 2A, 其中 *Ppd-D1* 位点作用最强,其次是 *Ppd-B1* 位点^[18]。Beales 等^[19]克隆了小麦 *Ppd* 基因,在 *Ppd-D1* 基因序列中发现编码序列上游存在 2089 bp 的缺失,并开发了 *Ppd-D1* 的功能标记,并已成功用于小麦光周期基因检测^[20-21]。

甘肃省地域狭长,气候类型复杂多变,西北部和东南部适宜种植品种的冬春性差异较大。河西灌溉春麦区、中部干旱春麦区、洮岷高寒春麦区及嘉陵江上游冬麦区、渭河上游冬麦区、陇东旱塬冬麦区的种质资源,从春性向冬性过渡^[22-23]。冬季和春季冻害常有发生,了解不同麦区小麦品种,特别是地方品种的春化、光周期基因的等位变异类型、组合及其与冬春性的关系,对选育抗寒性优良新品种和预防冬春季冻害意义重大。甘肃省不同生态区域育成品种的春化、光周期基因分布状况早有报道^[24],但小麦地方品种春化和光周期基因的分布不明确。本研究利用春化、光周期基因的特异性分子标记对甘肃省小麦地方品种的春化和光周期基因等位变异进行检测,以明确其春化和光周期基因等位变异类型及其分布特点,进一步比较小麦资源目录记载的冬春性与春化基因显性等位变异推导的

冬春性,并评判一致性,同时筛选优异地方种质资源,为其在甘肃及类似生态区域育种及生产中应用提供依据。

1 材料与方 法

1.1 供试材料

从甘肃省农作物种质资源库获取小麦地方品种 445 份,其中,河西灌溉区春小麦 117 份,中部旱地春小麦 47 份,洮岷高寒区春小麦 39 份,渭河上游冬小麦 46 份,陇东旱塬冬小麦 45 份,嘉陵江上游冬小麦 50 份,另外 101 份未标注种植区域。以上地方品种于 2021 年 10 月统一秋播于甘肃省农业科学院清水试验站,每份材料种植 1 行,行长 2.0 m,行距

20 cm,在腊熟期去杂去劣,取长相一致,相似度达到 95% 以上植株的籽粒进行春化和光周期基因检测。

1.2 DNA 提取及 STS 标记检测

采用 Yan 等^[6,9]、Milec 等^[10]、Fu 等^[11]及 Beales 等^[19]设计的特异性引物,进行春化基因(*Vrn-A1*、*Vrn-B1*、*Vrn-D1*、*Vrn-B3* 位点)和光周期基因(*Ppd-D1* 位点)等位变异检测。引物由上海生工生物工程公司合成。取成熟期籽粒提取 DNA, DNA 提取和 STS 检测方法同杨芳萍等^[14]。依据 Zhang 等^[12]报道的方法确定不同春化基因类型,依据 Beales 等^[19]的方法确定 *Ppd-D1* 位点等位变异类型 *Ppd-D1a* 和 *Ppd-D1b*, 引物和扩增片段见表 1。

表 1 *Vrn-1*、*Vrn-B3* 和 *Ppd-D1* 基因引物序列及相关信息

Table 1 Primer sequence and related information at *Vrn-1*、*Vrn-B3* and *Ppd-D1* loci

基因名称 Gene name	标记名称 Marker name	引物序列(5'-3') Primer sequence (5'-3')	等位变异(显/隐性) Allelic variation (dominant/recessive)	扩增片段(bp) Amplified fragment	参考文献 Reference
<i>Vrn-A1</i>	<i>Vrn1-AF</i>	GAAAGGAAAAATTCTGCTCG	<i>Vrn-A1a</i> (显性)	965+876	[6]
	<i>Vrn1-Int1R</i>	GCAGGAAATCGAAATCGAAG	<i>Vrn-A1b</i> (显性)	714	
			<i>Vrn-A1c</i> (显性)	734	
			<i>vrn-A1</i> (隐性)	734	
	<i>Intr1-A-F2</i>	AGCCTCCACGTTTGAAGTAA	<i>Vrn-A1c</i> (显性)	1170	[11]
	<i>Intr1-A-R3</i>	AAGTAAGACAACACGAATGTGAGA			
	<i>Intr1-C-F</i>	GCACTCCTAACCCACTAACC	<i>vrn-A1</i> (隐性)	1068	[11]
<i>Intr1-AB-R</i>	TCATCCATCATCAAGGCAAA				
<i>Vrn-D1</i>	<i>Intr1-D-F</i>	GTTGTCTGCCTCATCAAATCC			[11]
	<i>Intr1-D-R3</i>	GGTCACTGGTGGTCTGTGC	<i>Vrn-D1</i> (显性)	1671	
	<i>Intr1-D-R4</i>	AAATGAAAAGGAACGAGAGCG	<i>vrn-D1</i> (隐性)	997	
<i>Vrn-B3</i>	<i>Vrn4-B-INS-F</i>	CATAATGCCAAGCCGGTGAGTAC	<i>Vrn-B3</i> (显性)	1200	[9]
	<i>Vrn4-B-INS-R</i>	ATGTCTGCCAATTAGCTAGC			
	<i>Vrn4-BNOINS-F</i>	ATGCTTTCGCTTGCCATCC	<i>vrn-B3</i> (隐性)	1140	[9]
	<i>Vrn4-BNOINS-R</i>	CTATCCCTACCGCCATTAG			
<i>Vrn-B1</i>	<i>Intr1-B-F</i>	CAAGTGGAACGGTTAGGACA	<i>Vrn-B1a</i> (显性)	709+1235	[10-11]
	<i>Ex1-B-F3</i>	GAAGCGGATCGAGAACAAGA	<i>Vrn-B1b</i> (显性)	673+1199	[10-11]
	<i>Intr1-B-R3</i>	CTCATGCCAAAAATTGAAGATGA	<i>Vrn-B1c</i> (显性)	849	[10-11]
	<i>Intr1-B-R4</i>	CAAATGAAAAGGAATGAGAGCA	<i>vrn-B1</i> (隐性)	1149	[10-11]
<i>Ppd-D1</i>	<i>TaPpd-D1-F1</i>	ACGCCTCCCACTACTACTG			[19]
	<i>TaPpd-D1-R1</i>	TGTTGGTTCAAACAGAGAGC	<i>Ppd-D1b</i> (光周期敏感)	414	[19]
	<i>TaPpd-D1-R2</i>	CACTGGTGGTAGCTGAGATT	<i>Ppd-D1a</i> (光周期不敏感)	288	

1.3 冬春性、光周期敏感性划分及冬春一致性评判标准

基于春化基因等位变异的显隐性推测小麦的冬春性, *Vrn-1* 的 3 个基因中有 1 个 (*Vrn-A1* 和 *Vrn-D1* 位点) 或 1 个以上为显性等位变异时, 表现为春性^[12]; 3 个基因全为隐性且春播后正常拔节或 *vrn-A1+vrn-D1+Vrn-B1* 组合时为冬性^[12], *Vrn-1* 位点的 3 个基因全为隐性且不能正常拔节的材料为强冬性。因显性等位变异 *Vrn-B1* 或 *Vrn-D1* 需要部分春化, *Vrn-Ala* 对 *Vrn-B1* 或 *Vrn-D1* 有上位作用, 将春性品种进一步区分为春性 (具 *Vrn-Ala* 等位变异) 和弱冬性 (仅携带显性等位变异 *Vrn-B1* 或 *Vrn-D1*)。基于甘肃省小麦地方品种资源目录记载的冬春性, 将检测材料分为春性、弱冬性、冬性和强冬性。冬春性一致性依据标记检测的冬春性各类型材料数与甘肃省目录中记载的对应类型材料数的比值进行评判。光周期非敏感性评判基于标记检测结果, 携带 *Ppd-D1a* 的材料为光周期非敏感型, 携带 *Ppd-D1b* 的材料为光周期敏感型。

2 结果与分析

2.1 地方品种春化和光周期基因等位变异

用引物 *Vrn1-AF* 和 *Vrn1-Int1R* 检测 *Vrn-A1* 位点的等位变异, 445 份地方品种 2 份扩增失败, 11 份扩增出 965 bp 和 876 bp 条带, 说明这 11 份品种携带显性等位变异 *Vrn-A1a*, 432 份扩增出 734 bp 带型。扩增出 734 bp 带型品种的 *Vrn-A1* 位点可能是显性 *Vrn-A1c* 或隐性 *vrn-A1* 等位变异, 结合引物对 *Intr1-A-F2+Intr1-A-R3* 及 *Intr1-C-F+Intr1-AB-R*, 仅扩增到 1086 bp 的带型, 说明这 432 份品种携带 *vrn-A1* 隐性等位变异。

用引物 *Intr1-B-F+Ex1-B-F3* 和 *Intr1-B-R3+Intr1-B-R4* 进行多重 PCR 检测 *Vrn-B1* 位点的等位变异, 445 份品种中 11 份扩增失败; 49 份扩增出 709 bp 和 1235 bp 的带型, 说明这些材料携带显性等位变异 *Vrn-B1a*; 7 份扩增出 673 bp 和 1199 bp 的带型, 携带等位变异 *Vrn-B1b*; 2 份扩增出 849 bp 带型, 携带 *Vrn-B1c* 等位变异; 376 份扩增出 1149 bp 带型, 携带隐性等位变异 *vrn-B1*。显性等位变异 *Vrn-B1a*, *Vrn-B1b* 和 *Vrn-B1c* 分布频率分别为 11.0%、1.6% 和 0.5%, 隐性等位变异 *vrn-B1* 分布频率为 84.5%。

以引物对 *Intr1-D-F*, *Intr1-D-R3* 和 *Intr1-D-R4* 进行多重 PCR 检测 *Vrn-D1* 位点的等位变异, 38 份扩增失败, 300 份扩增出 1671 bp 的带型, 107 份扩

出 997 bp 特异带型, 表明 67.4% 的品种携带显性等位变异 *Vrn-D1*, 24.0% 的品种携带隐性等位变异 *vrn-D1*。

用引物 *Vrn4-B-INS-F* 和 *Vrn4-B-INS-R* 检测 *Vrn-B3* 位点等位变异, 445 份地方品种中 2 份扩增出 1200 bp 的特异带型, 表明这 2 份携带显性等位变异 *Vrn-B3* (无芒大白麦, 白金塔); 用互补引物 *Vrn4-BNOINS-F* 和 *Vrn4-BNOINS-R* 扩增其余材料, 均扩增出 1140 bp 的特异带型, 说明除 2 份携带显性等位变异 *Vrn-B3* 外, 其余均携带 *vrn-B3* 隐性等位变异。

用引物对 *TaPpd-D1-F1*, *TaPpd-D1-R1* 和 *TaPpd-D1-R2* 进行多重 PCR 检测 *Ppd-D1* 位点等位变异, 46 份扩增失败, 79 份扩增出 288 bp 的带型, 为光周期非敏感等位变异 *Ppd-D1a* (17.8%), 320 份材料扩增出 414 bp 的带型, 为光周期敏感等位变异 *Ppd-D1b* (71.9%)。

2.2 地方品种春化和光周期基因及其组合分布频率

445 份地方品种中发现 6 种春化基因显性等位变异 *Vrn-A1a*, *Vrn-B1a*, *Vrn-B1b*, *Vrn-B1c*, *Vrn-D1* 和 *Vrn-B3* 的频率分别为 2.5%、11.0%、1.6%、0.5%、67.4% 和 0.5% (表 2)。其中 *Vrn-D1* 的分布频率最高, 其次是 *Vrn-B1a*, 其余显性等位变异分布频率均很低。携带 1 个春化显性等位变异的材料 265 份, 分别为 *Vrn-A1a* (4 份)、*Vrn-B1a* (4 份)、*Vrn-B1b* (3 份)、*Vrn-B1c* (1 份)、*Vrn-D1* (251 份) 和 *Vrn-B3* (2 份)。2 个或 3 个显性等位变异组合有 *Vrn-A1a+Vrn-B1a* (4 份, 0.9%)、*Vrn-A1a+Vrn-D1* (2 份, 0.5%)、*Vrn-B1a+Vrn-D1* (40 份, 9.0%)、*Vrn-B1b+Vrn-D1* (3 份, 0.7%) 和 *Vrn-B1a+Vrn-D1+Vrn-B3* (1 份, 0.2%)、*Vrn-B1a+Vrn-B3* (1 份, 0.2%)。携带全隐性等位变异 *vrn-A1+vrn-B1+vrn-D1+vrn-B3* 的材料 87 份 (19.6%)。

春化基因等位变异及其组合在不同麦区内分布频率差异较大 (表 2)。*Vrn-A1a* 主要分布在洮岷高寒春麦区 (4 份, 10.3%), 河西灌溉春麦区、中部旱地春麦区和嘉陵江上游冬麦区少有分布。除渭河上游冬麦区外, 其余 5 个麦区均有 *Vrn-B1a* 分布, 且河西灌溉春麦区分布频率 (25 份, 21.4%) 最高, 其次为陇东旱塬冬麦区 (3 份, 6.7%) 和洮岷高寒春麦区 (2 份, 5.1%), 中部旱地春麦区 (2 份, 4.3%) 和嘉陵江上游冬麦区 (2 份, 4.0%) 较低。*Vrn-B1b* 主要分布在河西灌溉春麦区 (6 份, 5.1%)。*Vrn-B1c* 主要分布在河西灌溉春麦区 (1 份, 0.9%) 和嘉陵江上游冬麦区 (1 份, 2.0%)。*Vrn-D1* 显性等位变异在 6 大麦区广泛分布, 中部旱地春麦区最高 (39 份, 83.0%), 其次

为河西灌溉春麦区(90份,76.9%)和洮岷高寒春麦区(28份,71.8%),嘉陵江上游冬麦区(26份,52.0%)、渭河上游冬麦区(21份,45.7%)和陇东旱塬冬麦区(15份,33.3%)较低。携带 *Vrn-B3* 显性等位变异的材料共2份,其中1份属于河西灌溉春麦区,1份未标明种植区。携带 *Vrn-A1a+Vrn-B1a* 的4份材料未标明种植区域(4.0%)。携带 *Vrn-A1a+Vrn-D1* 的2份材料,属于河西灌溉春麦区和洮岷高寒春麦区。携带 *Vrn-B1a+Vrn-D1* 的40份材料在不同麦区均有分布,河西灌溉春麦区(23份,19.7%)最

高,嘉陵江上游冬麦区(5份,10.0%)高于洮岷高寒春麦区(2份,5.1%),渭河上游冬麦区(1份,2.2%)和中部旱地春麦区(1份,2.1%)均较低。携带 *Vrn-B1b+Vrn-D1* 的3份材料属河西灌溉春麦区(2.6%)。1份携带 *Vrn-B1a+Vrn-D1+Vrn-B3* 的材料未标明种植区。携带全隐性等位变异 *vrn-A1+vrn-B1+vrn-D1+vrn-B3* 的87份材料在不同麦区均有分布,陇东旱塬冬麦区分布频率最高(25份,55.6%),中部旱地春麦区最低(2份,4.3%)。

表2 地方品种春化和光周期基因及其组合在甘肃不同麦区的分布频率

Table 2 The frequency distribution of vernalization and photoperiod genes and their combination in landrace wheat varieties from different wheat regions in Gansu

基因类型 Gene type	品种数 No. of variety	总频率 (%) Total frequency	品种数/频率 (%) No. of variety/ Frequency							未标明 种植 麦区 PANM
			河西 灌溉 春麦区 HISWR	中部 旱地 春麦区 CDSWR	洮岷高寒 春麦区 HCTSWR	渭河上游 冬麦区 UWRWWR	陇东旱塬 冬麦区 LDDTWWR	嘉陵江 上游冬麦 UJRWWR		
<i>Vrn-A1a</i>	11	2.5	1/0.9	1/2.1	4/10.3			1/2.0	4/4.0	
<i>Vrn-B1a</i>	49	11.0	25/21.4	2/4.3	2/5.1		3/6.7	2/4.0	14/10.9	
<i>Vrn-B1b</i>	7	1.6	6/5.1						1/1.0	
<i>Vrn-B1c</i>	2	0.5	1/0.9					1/2.0		
<i>Vrn-D1</i>	300	67.4	90/76.9	39/83.0	28/71.8	21/45.7	15/33.3	26/52.0	81/80.2	
<i>Vrn-B3</i>	2	0.5	1/0.9						1/1.0	
<i>Ppd-D1a</i>	79	17.8	11/9.4	6/12.8	2/5.1	9/19.6	16/35.6	17/34.0	18/17.8	
<i>Vrn-A1a+Vrn-B1a</i>	4	0.9							4/4.0	
<i>Vrn-A1a+Vrn-D1</i>	2	0.5	1/0.9		1/2.6					
<i>Vrn-B1a+Vrn-D1</i>	40	9.0	23/19.7	1/2.1	2/5.1	1/2.2	2/2.0	5/10.0	6/5.9	
<i>Vrn-B1b+Vrn-D1</i>	3	0.7	3/2.6							
<i>Vrn-B1a+Vrn-D1+Vrn-B3</i>	1	0.2							1/1.0	
<i>Vrn-B1a+Vrn-B3</i>	1	0.2	1/0.9							
<i>vrn-A1+vrn-B1+vrn-D1+vrn-B3</i>	87	19.6	9/7.7	2/4.3	3/7.7	21/45.7	25/55.6	21/42.0	6/5.9	
<i>(vrn-A1+vrn-B1+vrn-D1+vrn-B3)/Ppd-D1a</i>	30	6.7	1/0.9	2/4.3	0/0	3/6.5	15/33.3	4/8.0	5/5.0	
<i>(vrn-A1+vrn-B1+vrn-D1+vrn-B3)/Ppd-D1b</i>	57	12.8	8/6.8		3/7.7	18/39.1	10/22.2	17/34.0	1/1.0	

频率为检测到材料占不同来源地材料数的比例

The frequency is the proportion of detected materials to the number of varieties originate region; HISWR: Hexi irrigation spring wheat region; CDSWR: Central dry spring wheat region; HCTSWR: High and cold Taomin spring wheat area; UWRWWR: Winter wheat region of upper Wei River; LDDTWWR: Winter wheat area on the drought tableland of Longdong; UJRWWR: Upper Jialing River winter wheat region; PANM: Planting area not marked

河西灌溉春麦区、中部旱地春麦区和洮岷高寒春麦区,显性等位变异 *Vrn-D1* 分布频率均较高,其次是显性等位变异 *Vrn-B1a*, *Vrn-A1a*, *Vrn-B1b*, *Vrn-B1c* 和 *Vrn-B3* 分布频率均较低;渭河上游冬麦区、陇东旱塬冬麦区和嘉陵江上游冬麦区,同样是 *Vrn-D1* 分布频率最高,其次是 *Vrn-B1a*,其余显性等位变异无分布或分布频率极低。

光周期基因非敏感等位变异 *Ppd-D1a* 的分布频率为 17.8%(79份),在不同麦区均有分布,陇东旱塬冬麦区的分布频率(16份,35.6%)高于嘉陵江上游冬麦区(17份,34.0%),渭河上游冬麦区(9份,19.6%)高于中部旱地春麦区(6份,12.8%),河西灌溉春麦区(11份,9.4%)和洮岷高寒春麦区(2份,5.1%)较低。携带 *(vrn-A1+vrn-B1+vrn-D1+vrn-B3)/Ppd-D1a* 的

材料30份,除洮岷高寒春麦区外,其余5个麦区均有分布,且陇东旱塬冬麦区分布频率(15份,33.3%)最高,河西灌溉春麦区(1份,0.9%)最低。携带(*vrn-A1+vrn-B1+vrn-D1+vrn-B3*)/*Ppd-D1b*组合的材料57份,除中部旱地春麦区外,其余5个麦区均有分布,且渭河上游冬麦区分布频率最高(18份,39.1%),河西灌溉春麦区(8份,6.8%)最低。3个春麦区中,中部旱地春麦区*Ppd-D1a*的分布频率(12.8%)高于河西灌溉春麦区(9.4%)和洮岷高寒春麦区(5.1%);3个冬麦区中,*Ppd-D1a*在陇东旱塬冬麦区(35.6%)和嘉陵江上游冬麦区的分布频率(34.0%)较高,渭河上游冬麦区的分布频率(19.6%)低。

2.3 基于资源目录记载的冬春性和 *Vrn-1* 显隐性等位变异推测的冬春性的一致性分析

按照甘肃省地方品种资源目录记载的冬春性,445份材料中83份为春性,占比18.7%;175份为弱冬性,占比39.3%;63份为冬性,占比14.2%;42份为强冬性,占比18.4%;82份未记载冬春性,占比18.4%(表3)。资源目录记载的83份春性材料全部分布于春麦区,其中*Vrn-A1a*、*Vrn-B1a*、*Vrn-D1*和*Vrn-B3*的频率分别为3.6%、15.7%、85.5%和1.2%;

这些材料全部携带春化基因显性等位变异,与基于资源目录记载的春性材料一致率为100%。资源目录记载的175份弱冬性材料主要分布于春麦区和嘉陵江上游冬麦区,其中*Vrn-A1a*、*Vrn-B1a*、*Vrn-B1b*、*Vrn-B1c*和*Vrn-D1*的频率分别为2.9%、13.1%、3.4%、1.1%、69.1%,*Vrn-1*位点全隐性等位变异频率为14.3%;其中126份基因型具有*Vrn-B1a*、*Vrn-B1b*、*Vrn-B1c*和*Vrn-D1*显性等位变异,其一致性达72.0%。资源目录记载的冬性材料主要分布在冬麦区,其中*vrn-A1+vrn-D1+Vrn-B1*和*Vrn-1*的3个位点全隐性且春播后正常拔节的频率分别为4.8%(3份)和63.5%(40份),基因型推测和资源目录记载的冬性品种一致率达68.3%。资源目录记载的强冬性材料主要分布在冬麦区,其中*Vrn-1*的3个位点全隐性且不能正常拔节的频率64.3%(27份),即基因型推断与资源目录记载的强冬性品种一致性达64.3%。从春性到强冬性,春化基因显性等位变异分布频率逐渐降低,*Vrn-1*3个位点全隐性分布频率逐渐升高。基于基因型推测的冬春性与资源目录记载的冬春性的一致性较高(64.3%~100.0%),从春性到强冬性,一致率逐渐降低。

表3 地方品种冬春性及 *Vrn-1* 等位变异的分布频率

Table 3 Frequency of dominant allelic variation and all recessive allelic combinations at *Vrn-1* loci and winter-spring nature from Gansu landrace wheat

类型 Type	材料数 Number	频率(%) Frequency	<i>Vrn-A1a</i>		<i>Vrn-B1a</i>		<i>Vrn-B1b</i>		<i>Vrn-B1c</i>	
			材料数 Number	频率(%) Frequency	材料数 Number	频率(%) Frequency	材料数 Number	频率(%) Frequency	材料数 Number	频率(%) Frequency
春性 Spring	83	18.7	3	3.6	13	15.7	0	0	0	0
弱冬性 Weak winter	175	39.3	5	2.9	23	13.1	6	3.4	2	1.1
冬性 Winter	63	14.2	0	0	3	4.8	0	0	0	0
强冬性 Strong winter	42	9.4	0	0	1	2.4	0	0	0	0
未区分 Un-discrimination	82	18.4	3	3.7	9	11.0	1	1.2	0	0

类型 Type	<i>Vrn-D1</i>		<i>Vrn-B3</i>		<i>vrn-A1+vrn-B1+vrn-D1</i>		基因推测材料数 No. of accessions based on genotype	一致性(%) Consistency
	材料数 Number	频率(%) Frequency	材料数 Number	频率(%) Frequency	材料数 Number	频率(%) Frequency		
春性 Spring	71	85.5	1	1.2	0	0	83	100.0
弱冬性 Weak winter	121	69.1	0	0	24	13.7	126	72.0
冬性 Winter	22	34.9	0	0	40	63.5	43	68.3
强冬性 Strong winter	15	35.7	0	0	27	64.3	28	64.3
未区分 Un-discrimination	71	86.6	1	1.2	3	3.7		

2.4 冬春性优异地方种质资源筛选

甘肃省地域狭长,西北部和东南部适宜种植品种的冬春性差异较大。中西部种植品种春性强、抽穗早,生长后期可避开干热风危害;东南部麦区春性逐渐变弱(陇南麦区),冬性渐强(定西、天水南部等),以上区域种植的小麦由春性向弱冬性过度,早抽穗适期灌浆,可避免后期高温青干逼熟;靠近定西、天水东北边的渭河上游及平凉、庆阳泾河流域的陇东旱塬区域冬季较为寒冷,种植区域11月份至次年1月份温度能满足春化需求,完成营养生长向生殖生长的转变,不仅确保小麦成长正常,且避免倒春寒产生的冻害,这些区域种植的小麦为冬性和强冬性。依据春化显性等位变异 *Vrn-A1* 对 *Vrn-B1* 和 *Vrn-D1* 的上位作用、携带 *vrn-D1* 的材料抗寒性强等信息及资源目录记载的冬春性,筛选出284份优异地方种质资源(详见 <https://doi.org/10.13430/j.cnki.jjgr.20230320003>,附表1),其中83份春性强的品种,主要来源于甘肃中西部春麦区,可在中西部春麦区及类似生态区域应用;119份仅携带显性等位变异 *Vrn-D1* 的弱冬性品种,主要来自甘肃省中西部春麦区及东南部秋播冬麦区,可在东南部较为温暖区域使用;82份冬性及强冬性的品种,主要来自陇东旱塬及渭河上游冬麦区,抗寒性强,可在较为寒冷的渭河上游、陇东旱塬冬麦区充分应用,以这些品种为亲本选育新品种或在生产中应用,可避免冬季和春季冻害发生。

3 讨论

3.1 甘肃地方品种春化基因等位变异类型的丰富性及不同区域的分布频率

445份地方品种中共发现6种春化等位变异,且分布频率差异较大,从河西灌溉春麦区、中部旱地春麦区、洮岷高寒春麦区、嘉陵江上游冬麦区、渭河上游冬麦区到陇东旱塬冬麦区,春化显性等位变异的频率依次降低,而隐性等位变异逐渐升高。仅1个春化显性等位变异组合有6种;2个或3个显性等位变异组合有6种,因显性等位变异分布频率低,导致携带以上显性等位变异组合的频率更低。2种以上显性变异组合中,除 *Vrn-B1a*+*Vrn-D1* 外,其余显性春化等位变异组合的材料全部分布在春麦区,而全隐性等位变异 *vrn-A1*+*vrn-B1*+*vrn-D1*+*vrn-B3* 的分布频率从西南向东北呈上升趋势,且陇东旱塬冬麦区(55.6%)>渭河上游冬麦区(45.7%)>嘉陵江上游冬麦区(42.0%)>河西灌溉春麦区(7.7%)=洮

岷高寒春麦区(7.7%)>中部旱地春麦区(4.3%)。春化基因的显性等位变异可以减少或消除小麦对低温春化作用的需求,其中,*Vrn-A1*位点显性等位变异无春化需求,*Vrn-B1*与*Vrn-D1*位点显性等位变异需要部分春化需求,且*Vrn-A1*位点对*Vrn-B1*与*Vrn-D1*位点有上位作用;说明甘肃大部分地方品种需要部分或较强的春化需求。

姜莹等^[13]对国内153份地方小麦品种进行春化基因鉴定发现,显性*Vrn-D1*在所有的春化基因等位变异类型中所占的比例最高(60.9%),其次是*Vrn-A1a*(5.9%)和*Vrn-B1*(5.2%);而且春化显性等位变异主要在春麦区,从南方4大冬麦区向北方冬麦区*Vrn-D1*等位变异分布频率依次减低,中国冬麦区小麦地方品种由南到北对春化的要求依次增强。本研究中*Vrn-D1*、*Vrn-B1*、*Vrn-A1a*等显性等位变异类型和分布趋势和姜莹等^[13]的研究结果基本一致,说明甘肃省地方品种从西南到东北春化需求增强。Zhang等^[12]对278份育成小麦品种春化基因等位变异检测,*Vrn-D1*分布频率最高,其次是*Vrn-A1*、*Vrn-B1*和*Vrn-B3*,与本研究中4个春化基因显性位点的分布趋势基本相同,但分布频率差异较大。Derakhshana等^[25]报道伊朗地方品种主要携带*Vrn-D1*(67.4%)和*Vrn-B1*(48.0%)显性等位变异,*Vrn-B1*分布频率远高于本研究该位点显性等位变异频率,可能与伊朗材料血缘不同有关。东北春麦区黑龙江育成品种*Vrn-A1*位点有3种显性等位变异^[26],而本研究只有一种,表明东北春麦区的品种携带*Vrn-A1*显性等位变异的类型较本研究选用材料丰富,一方面可能与东北春麦区春化基因来源于育成品种有关,另外也可能与东北春麦区种植春小麦,不需要春化作用有关。张博等^[24]对甘肃96份育成品种的春化位点*Vrn-1*和*Vrn-B3*进行了检测,认为春麦区存在*Vrn-A1*、*Vrn-B1*显性等位变异,冬麦区存在*Vrn-B1*和*Vrn-D1*显性等位变异,不存在*Vrn-B3*显性等位变异;与研究结果相比,除*Vrn-B3*显性等位变异分布频率不同外,春麦区*Vrn-A1*、*Vrn-B1*显性等位变异和冬麦区中*Vrn-B1*和*Vrn-D1*显性等位变异种类和分布区域基本一致,说明地方品种春化基因类型较育成品种更丰富,显性等位变异分布区域一致,地方品种可充分应用于现代小麦育成品种改良。

3.2 甘肃地方品种光周期基因*Ppd-D1*位点非敏感等位变异*Ppd-D1a*的分布频率

甘肃地方品种非敏感等位变异*Ppd-D1a*冬麦

区频率高于春麦区;全隐性春化基因组合 *vrn-A1+vrn-B1+vrn-D1+vrn-B3* 结合 *Ppd-D1a* 的材料 30 份,除洮岷高寒春麦区外,其余不同麦区均有分布,且冬麦区高于春麦区;全隐性春化基因组合 *vrn-A1+vrn-B1+vrn-D1+vrn-B3* 结合 *Ppd-D1b* 的材料共 57 份,冬麦区频率仍高于春麦区,但不同冬麦区和春麦区 *Ppd-D1a* 和 *Ppd-D1b* 的频率不同;从春麦区向冬麦区光周期非敏感基因 *Ppd-D1a* 频率逐步提高,春麦区 *Ppd-D1b* 的频率高于 *Ppd-D1a*,不同冬麦区光周期基因等位变异处于互补型分布。

Yang 等^[20]对国内 926 份地方和育成品种进行了 *Ppd-D1a* 检测,地方品种和改良种 *Ppd-D1a* 的分布频率分别为 38.60% 和 90.60%,除新疆和甘肃西北高纬度地区的品种外,1970 年以后的育成品种均携带 *Ppd-D1a* 非敏感等位变异,无论是地方品种还是育成品种携带该等位变异的频率均从北向南逐渐升高。本研究中 *Ppd-D1a* 分布频率和区域与 Yang 等^[20]中的结果基本一致;但东北春麦区黑龙江省育成品种光周期非敏感等位变异 *Ppd-D1a* 的分布频率超过 40.00%^[26]。甘肃省育成品种^[24]无论是春麦区还是冬麦区 *Ppd-D1a* 的频率均高于本研究结果。说明和其他国内外小麦育成品种一样,甘肃省和黑龙江的品种选育合理利用了光周期基因不敏感等位变异 *Ppd-D1a*,从甘肃省的西北部到东南部频率逐步提高,促使小麦品种从北部到南部对光照的要求大大降低,不论是短日照还是长日照,携带 *Ppd-D1a* 等位变异的小麦均能正常抽穗,拓展了小麦的适宜种植区域。

3.3 春化基因等位变异分布与冬春性划分一致性比较

冬春性是小麦春化阶段的生长发育特性,春化发育至少受控于 *Vrn-1*、*Vrn-2* 和 *Vrn-3* (*Vrn-B3*) 的基因组位点^[4]。*Vrn-1* 是调控小麦春化作用的关键基因,由一个或几个 (*Vrn-A1*、*Vrn-B1*、*Vrn-D1*) 显性突变位点控制^[5-6],春化基因显性位点 *Vrn-A1* 对 *Vrn-B1* 和 *Vrn-D1* 有上位作用,且有 *Vrn-A1* > *Vrn-B1* > *Vrn-D1* 的趋势^[27-28],但 Amo 等^[18]认为 3 个等位基因效应相似,可能与研究材料不同有关。姜莹等^[13]对中国十大麦区 153 份地方品种的春化位点 *Vrn-A1*、*Vrn-B1*、*Vrn-D1* 和 *Vrn-B3* 等位变异的检测结果与记载表型的一致性分析表明,春麦区的一致性较高,冬麦区的一致性较低,与本研究结果基本一致,但本研究不同麦区的一致性频率较高,可能与将 *Vrn-B1*

和 *Vrn-D1* 归为弱冬性有关。张晓科等^[29]的 75 份冬性小麦品种 *Vrn-A1* 的检测结果表明,97.30% 的品种的春化基因型与生产中的冬性习性一致。该研究在冬小麦中检测的春化基因型与生产中的冬春性一致性高于本研究在冬小麦中的一致性,可能与材料类型不同有关。

春化和光周期基因对小麦的抽穗、开花影响较大,资源目录记载的冬春性类型与基于标记检测的春化显性等位变异和全隐性组合推测的冬春性的一致性,从春麦区到冬麦区逐渐降低。不一致性不仅与显性等位变异 *Vrn-A1*、*Vrn-B1* 和 *Vrn-D1* 对低温春化的敏感性和要求有关,也与光周期基因 *Ppd-A1*、*Ppd-B1*、*Ppd-D1* 非敏感或敏感等位变异有关^[20-21]。本研究不一致材料大部分为 *Ppd-D1* 敏感型,由于 *Ppd-A1* 和 *Ppd-B1* 位点缺乏有效性标记,两位点等位变异未检测,而光周期位点敏感等位变异会导致抽穗和开花延迟^[30],因此资源目录中抽穗期延迟品种的冬春性有可能将春性记录为冬性、冬性记录为强冬性,这一结论有待于进一步验证。

3.4 甘肃省地方品种的冬春性分布

低温胁迫是小麦广泛分布的最主要限制因素,处于黄淮海麦区的甘肃省天水、陇南、陇东等区域冬春季冻害常有发生,秋播冬麦区的耐低温小麦新品种选育应用必不可少^[31]。春化、光周期等基因决定小麦的耐寒性,冬性小麦品种需置于小于等于 4℃ 的低温 4~8 周,诱导开花。研究表明 *Vrn1* 是小麦抗寒性的关键性遗传调控位点之一,显性基因 *Vrn1* 的存在会显著降低品种的抗寒性,具有 2 个或 3 个 *Vrn1* 显性等位变异的品种一般抗寒性较差,且携带显性等位变异 *Vrn-A1a* 或 *Vrn-A1b* 的品种较携带 *Vrn-B1* 或 *Vrn-D1* 的品种对低温更敏感,携带对应隐性等位变异的材料对低温较迟钝,而 3 个位点均为隐性基因的品种具有强的抗寒性^[29-31]。本研究依据春化显性等位变异分布及其资源目录冬春性记载,筛选出携带显性等位变异的 83 份春性、119 份弱冬性(经基因型检测,仅携带 *Vrn-B1* 和 *Vrn-D1* 显性等位变异的材料)和 40 份冬性、42 份强冬性地方品种材料。说明被检测材料中可利用的春性、弱冬性品种较冬性、强冬性品种更丰富,筛选出的以上地方品种,根据种植区域的要求,分别在甘肃省及类似生态条件的春性、弱冬性、冬性小麦育种中充分应用,以改良品种的抗寒性和丰产性。

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附表 1 经筛选后适用于各生态区域种植的材料

Table S1 Accessions suitable for various ecological areas

资源可用区域 Resource availability area	种质名称 Name	<i>Vrn-A1</i>	<i>Vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1</i>	冬春性 Winter or spring type
1	三根芒	<i>Vrn-A1a</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1a</i>	-
1	拉木台板麦	<i>Vrn-A1a</i>	<i>Vrn-B1a</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	春
1	上饶种	<i>Vrn-A1a</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	春
1	大头兰麦	<i>Vrn-A1a</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
1	秃头兰麦	<i>Vrn-A1a</i>	<i>vrn-B1</i>	-	<i>Ppd-D1b</i>	弱冬
1	兰选麦	<i>Vrn-A1a</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
1	白齐麦	<i>Vrn-A1a</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
1	红麦	<i>Vrn-A1a</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
1	大田区小麦	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	二区小麦	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	白光头	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>vrn-D1</i>	<i>Ppd-D1a</i>	春
1	大红头	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	早麦子	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	毛穗子	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	红矮麦	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	油麦	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	拉木台板麦	<i>Vrn-A1a</i>	<i>Vrn-B1a</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	春
1	台子 39	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>Vrn-D1</i>	<i>Ppd-D1a</i>	春
1	红疙瘩	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>Vrn-D1</i>	<i>Ppd-D1a</i>	春
1	红光光头	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>Vrn-D1</i>	-	春
1	红芒麦	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>Vrn-D1</i>	<i>Ppd-D1a</i>	春
1	武都兰麦	<i>vrn-A1</i>	<i>Vrn-B1c</i>	<i>vrn-D1</i>	<i>Ppd-D1a</i>	弱冬
1	山西红	<i>vrn-A1</i>	<i>Vrn-B1c</i>	<i>vrn-D1</i>	<i>Ppd-D1a</i>	弱冬
1	毛红麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	-	春
1	定西红麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	-	春
1	短腰麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	长腰麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	中孚红芒麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	二芒麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	洋春麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	禾春麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	方齐头	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	小齐头麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	齐头麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	青楞头大麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	小麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	丁新小麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	龙门小麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	有芒小麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1a</i>	春
1	有须小麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1a</i>	春
1	忠信小麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	长芒芒	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	白半芒	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	-	春
1	青大芒	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春

1	白扎芒	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	黑芒	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	灰黄子小白麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	短白麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	白光光头	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	白雀儿头	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	白秃头	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	-	春
1	灰大头	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	紫麦子	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	腊穗子	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	-	春
1	白芒子	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	红秃子	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	-	春
1	红毛麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	豌豆麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	白矮麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	大景麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	红泉麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	-	春
1	有芒冰麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	一枝麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	增城麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	白短麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	长穗麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1a</i>	春
1	山麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	糠麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1a</i>	春
1	小辈力麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	大粒种	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1a</i>	春
1	卷芒和尚头	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	红毛壳	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	白剑口	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	杂老汉	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	六月黄	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	杂丽巴	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	芒白长穗	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	白鞭梢	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	白春麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	大白麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	红春麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	春
1	绿麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	-	春
1	阿勃	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1a</i>	春
2	白兰麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	青兰麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	老芒麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	白穗老芒麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	春老芒麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	短红芒麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1a</i>	弱冬
2	小红芒麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	高芒麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1a</i>	弱冬
2	黑芒麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	凉州扎芒麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬

2	大和尚头	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	小和尚头	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	红齐麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	安西小麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	铁小麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	白小麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	白小麦子	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	老白麦	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	齐头白麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	大麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	红大麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	白大麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	-	弱冬
2	红麦子	<i>vrn-A1</i>	<i>Vrn-B1b</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	兰州红	<i>vrn-A1</i>	<i>Vrn-B1b</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	兰州麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	短麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	杂麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	杂麦子	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	糜麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	金麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1a</i>	弱冬
2	春麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	老春麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	大光头	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	红木铣板	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	红铣板	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	瞎石五	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	小青芒	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	红青芒	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	青芒子(短、有毛)	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	大青芒	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	红火烧麦	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	红火穗	<i>vrn-A1</i>	<i>Vrn-B1b</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	火麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	大红火禾	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	小红火穗	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	红雀扎头	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	长芒雀儿头	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	银包金	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	小火麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	火里炎	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	秃头麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	有芒白头麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	秃芒齐头麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	-	弱冬
2	小齐头	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	红齐头	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	白齐头	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1a</i>	弱冬
2	大白芒	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	红芒子	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	小红芒	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬

2	老红芒	<i>vrn-A1</i>	-	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	白光葫芦头	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	白壳葫芦头	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	半芒子	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	灰麦子	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	龙麦子	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	麦子	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	红大芒	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1a</i>	弱冬
2	红短芒	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	红穗子	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	红桃红	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	红玉皮	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	红板麦	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	红羊尾	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	红扎芒子	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	红长穗子	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1a</i>	弱冬
2	红毛麦子	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	红扎芒	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	马尾巴	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	白和尚	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	五爪龙	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1a</i>	弱冬
2	歪脖子	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1a</i>	弱冬
2	小禾麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	小青麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	三下齐	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	榆中红	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	紫杆子	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	白老来变	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	大白见口	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	小辈芥口	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	建条推子	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	新源井平麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	白长芒	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	-	弱冬
2	白利芒	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	白东东	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	白羊尾	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	白大毛	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	金黄麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	铁堡麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	高岔麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	镇番麦	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	金塔麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	陇东麦	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	白矮麦	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	老毛麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	灰毛麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	泾阳麦	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	长矮麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	白大头	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬

2	白玉麦	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	半截芒	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	和尚头	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	和尚头	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	红光头	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	红小麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	金包银	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	蚂蚱麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	青芒麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	小白麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
2	小红麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	弱冬
3	老兰麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	强冬
3	庆阳陕西白麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	强冬
3	早白麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	强冬
3	红白麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	强冬
3	合水瞎八斗	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1a</i>	强冬
3	红半芒	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	强冬
3	红半芒	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	强冬
3	白蚂蚱	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	强冬
3	华池白蚂蚱	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1a</i>	强冬
3	镇原白蚂蚱	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1a</i>	强冬
3	有芒白蚂蚱	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	强冬
3	环县小青芒	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1a</i>	强冬
3	宁县和盛兰花麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1a</i>	强冬
3	庆阳白箭头	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	强冬
3	庆阳白鱼儿麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1a</i>	强冬
3	鱼儿麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1a</i>	强冬
3	镇原红曹麦	-	-	-	<i>Ppd-D1a</i>	强冬
3	正宁菜黄麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1a</i>	强冬
3	正宁宫河饿死牛	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1a</i>	强冬
3	正宁三月黄	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1a</i>	强冬
3	火穗子	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	强冬
3	红穗红火麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	强冬
3	红芒红梢麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b/Ppd-D1a</i>	强冬
3	老红早麦	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	强冬
3	白早麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	强冬
3	红早麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1a</i>	强冬
3	有芒洋麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1a</i>	强冬
3	白川麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1a</i>	强冬
3	红川麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	强冬
3	有芒青熟麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1a</i>	强冬
3	白葛条	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	强冬
3	白锁条	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	强冬
3	红茧麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1a</i>	强冬
3	茧儿麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	强冬
3	宁县石鼓石大头	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1a</i>	强冬
3	正宁瓦沟圈红二笨	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	强冬
3	庆阳连麸白	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	强冬
3	庆阳露里滴	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	强冬

3	有芒河南红	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1a</i>	强冬
3	凤翔麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1a</i>	强冬
3	白芒麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>Vrn-D1</i>	<i>Ppd-D1b</i>	强冬
3	红火麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	强冬
3	大兰麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	冬
3	白老芒麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	冬
3	红老芒麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	冬
3	一芒麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	冬
3	有芒麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	冬
3	清水-芒红齐麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	冬
3	瞎八斗	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	冬
3	秃蚂蚱	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1a</i>	冬
3	齐蚂蚱	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	冬
3	白秃蚂蚱	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	冬
3	兰花麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1a</i>	冬
3	白花麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	冬
3	白箭头	<i>vrn-A1</i>	<i>vrn-B1</i>	-	<i>Ppd-D1b</i>	冬
3	箭头红	<i>vrn-A1</i>	<i>Vrn-B1a</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	冬
3	箭儿头	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	冬
3	箭儿麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	冬
3	菜花黄	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1a</i>	冬
3	三月黄	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1a</i>	冬
3	红巧头	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	冬
3	有芒红梢头	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	冬
3	短芒红梢麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	冬
3	火麦儿	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	冬
3	白火麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	冬
3	红露仁	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1a</i>	冬
3	大红齐	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	冬
3	红索条	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	冬
3	红二齐	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	冬
3	白金麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	-	冬
3	白马莲	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	冬
3	白软秆	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	冬
3	下县麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1a</i>	冬
3	川儿麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1a</i>	冬
3	白齐麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1a</i>	冬
3	红齐麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1a</i>	冬
3	蚂蚱麦(白)	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	冬
3	有芒红蚂蚱	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	冬
3	有芒蚂蚱麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	冬
3	凤翔麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	冬
3	秃白麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	<i>Ppd-D1b</i>	冬
3	秃儿麦	<i>vrn-A1</i>	<i>vrn-B1</i>	<i>vrn-D1</i>	-	冬

1、2 和 3 分别代表中西部春麦区、较为温暖的东南部弱冬性区域和较为寒冷的冬麦区。-代表缺失数据

1,2 and 3 means the spring wheat district in the Midwest of Gansu, the warm southeast region with weak winteriness and the cold winter wheat areas. - means missing