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灌溉与旱作条件下源库关系对小麦籽粒淀粉粒度分布的调节效应

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摘要:在灌溉和旱作两种栽培条件下,研究了源库关系对小麦籽粒淀粉粒度分布特征的影响。结果表明,山农 8355(大穗型)各处理 A 型淀粉粒体积分布、表面积分布百分比成熟期较灌浆中期明显提高,灌溉栽培条件下增幅分别在 17.65% ~22.88%、35.8% ~39.05%,旱作栽培条件下增幅分别在 1.46% ~2.82%、7.05% ~8.12%;山农 8355 各处理 B 型淀粉粒体积分布、表面积分布百分比成熟期较灌浆中期明显降低,灌溉栽培条件下降幅分别在 34.78% ~40.47%、11.73% ~13.77%,旱作栽培条件下降幅分别在 5.08% ~7.67%、2.52% ~3.43%。济南 17(多穗型)各处理下成熟期与灌浆中期的 A、B 淀粉粒体积分布、表面积分布百分比,其变化趋势与山农 8355 相同,其中 A 型淀粉粒灌溉栽培条件下增幅分别在 1.56% ~5.98%、2.96% ~9.92%,旱作栽培条件下增幅分别在 1.76% ~4.52%、1.28% ~8.63%;B 型淀粉粒灌溉栽培条件下降幅分别在 3.46% ~12.27%、1.02% ~4.18%,旱作栽培条件下增幅分别在 5.31% ~9.87%、0.58% ~3.13%。在灌溉和旱作栽培条件下源库调节对两品种 A、B 型淀粉粒粒度分布的影响趋势表现为,减源处理 A 型淀粉粒较同期同品种对照处理的体积分布、表面积分布百分比显著提高,减库处理较同期同品种对照处理显著降低,B 型淀粉粒粒度分布变化趋势则与之相反。

关键词:小麦;源库关系;淀粉粒;粒度分布

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Effect of source-sink regulation on grain starch granule distribution in irrigated and rainfed wheats

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Abstract: To investigate the effect of source-sink regulation on the distribution of starch granule size, two typical wheat (*Triticum aestivum* L.) cultivars, Shannong8355 (large-spike type) and Jinan17 (multi-spike type) were planted under both irrigated and rainfed conditions at the Tai'an Experimental Farm of Shandong Agricultural University in 2006 — 2007 growth season. Results indicated that the percentages of volume and surface area of A-type starch granules in mature grain were obviously higher than those in mid-filling stage in both cultivars. Under irrigated conditions, the increased rates of volume and surface area of A-type starch granules were 17.65% — 22.88%, 35.8% — 39.05%, respectively, in Shannong8355, and 1.56% — 5.98%, 2.96% — 9.92%, respectively, in Jinan17. Under rainfed conditions, the corresponding rates were 1.46% — 2.82%, 7.05% — 8.12%, respectively, in Shannong8355, and 1.76% — 4.52%, 1.28% — 8.63%, respectively, in Jinan17. On the contrary, either in irrigated or in rainfed cultivation condition, the volume and surface area of B-type starch granules in mature grain had markedly lower percentages than those in mid-filling

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stage in both cultivars. The alteration of source-sink relation resulted in the noticeable changes of grain starch granule distribution in both cultivation conditions. The percentages of volume and surface area of A-type starch granules were significantly enhanced by the removal of flag leaf and decreased by the removal of half spikelets. As for B-type starch granules, the removal of flag leaf resulted in the decreases in the percentages of volume and surface area, and the significant enhance of the percentages of volume and surface area occurred due to the removal of half spikelets.

Key Words: winter wheat (*Triticum aestivum* L.); source-sink relation; starch granule; granule distribution

淀粉是小麦籽粒产量的主体成分,占籽粒干重的65% ~75% [1],是影响小麦加工品质的重要因素。淀粉在小麦籽粒胚乳中以淀粉粒的形式存在。按其大小、形状小麦籽粒淀粉粒可分为 A 型和 B 型两种。A 型淀粉粒较大,直径 10 ~35μm,呈盘状或透镜状,占小麦胚乳总淀粉粒数量的 3%;B 型淀粉粒较小,直径 1 ~10μm,呈球形状,其数量占总淀粉粒数量的 90% 以上[2,3]。

小麦不同类型品种及在籽粒发育不同阶段所形成的淀粉粒,其形态、体积存在明显差异,且显著受环境条件影响,从而最终影响到籽粒品质[4~9]。研究表明,小麦胚乳 A 型淀粉粒在小麦开花后的4 ~5d 开始形成,持续到胚乳细胞分裂结束期,B 型淀粉粒于花后 12 ~14d 在形成 A 型淀粉粒的质体中开始形成[10~12]。A 型与 B 型淀粉粒的淀粉组分组成不同,A 型淀粉粒的直连淀粉含量较高,约为 30% ~36%,B 型淀粉粒则较低,约为 24% ~27%[13]。淀粉粒体积分布状况与淀粉糊化特性密切相关,小淀粉粒的糊化峰值粘度明显高于大淀粉粒,淀粉粒大的面粉,其峰值粘度下降明显[14];大淀粉粒的起始温度、峰值温度和热焓值均比小淀粉粒高[15]。小麦质地与淀粉粒径分布存在一定的相关性,硬质小麦比软质小麦具有较多的小淀粉粒[12]。强筋小麦比弱筋小麦籽粒中具有较高的 B 型淀粉粒的体积百分比[16]。Raeker 等[5]研究表明, <2.8μm 的淀粉粒体积百分比与籽粒蛋白质含量呈正相关, <9.9μm 的淀粉粒体积百分比均与淀粉含量呈负相关, 9.9 ~18.5μm 的淀粉粒体积百分比与直链淀粉含量呈显著正相关。戴忠民等[16]和蔡瑞国等[17]研究表明,栽培技术及光温环境变化对籽粒胚乳淀粉粒数目、体积和表面积分布能产生显著的影响。

源库关系是影响小麦籽粒发育和籽粒淀粉形成积累的重要因素。张秋英等[18]研究认为,小麦源的供应能力基本能满足籽粒发育需求,籽粒库容以及物质转化能力是影响籽粒淀粉积累的主要因素。赵会杰等[19]研究提出,大穗型品种在灌浆中后期有较强的同化物生产能力,为籽粒发育提供了较好的物质基础,同时库端转化利用同化物的能力较强,从而使籽粒中后期具有较高的淀粉积累和灌浆速率。高松洁等[20]和王文静[21]研究表明,大穗型品种的淀粉积累速率和相关酶活性的峰值出现较晚,但持续时间较长,在灌溉中后期下降较慢。王振林等[22]等研究表明,大穗型品种籽粒淀粉积累时间长、速率高,在灌浆的中后期比多穗型品种具有更强的淀粉合成能力,但对水分反应敏感。

然而,关于源库关系改变对籽粒淀粉粒形成与粒度分布的影响,迄今研究较为薄弱。为此,本试验选用两个穗型的小麦品种在灌溉与旱作条件下研究了源库关系改变对籽粒淀粉粒度分布的调节效应,研究结果将有助于进一步加深对小麦胚乳淀粉粒的生物合成及其调节机制的认识,为小麦高产优质栽培提供理论依据和技术途径。

1　材料与方法

1.1　材料与种植方式

试验以小麦大穗型品种山农 8355 和多穗型品种济南 17 为材料,于 2006 年 10 月 ~2007 年 6 月在山东农业大学泰安试验农场进行。试验田 0 ~20 cm 土壤含全氮 0.091%,碱解氮、速效磷、速效钾分别为 87.2 、18.6 和 57.5 mg kg^{-1}。种植密度 180 万株 hm^{-2}。小区面积为 3 m×3 m =9 m^2。播种期为 2006 年 10 月 6 日。收获期为 2007 年 6 月 6 日。播种前施基肥纯 N、P_2O_5和 K_2O 分别为 120、75 kg hm^{-2}和 120 kg hm^{-2},拔节期追施纯 N 120 kg hm^{-2}。在本试验灌溉与旱作栽培条件下两品种成熟期产量构成因素列于表 1。

表 1 灌溉与旱作栽培条件下小麦成熟期产量构成因素的比较

Table 1 Comparison of grain yield components at maturity under both irrigated and rainfed conditions

品种 Cultivar	处理 Treatment	穗粒数 Grains·ear^{-1}	粒重 Weight·grain^{-1}(mg)	单位面积穗数 Ears·m^{-2}
山农 8355	I-CK	47	49.1	356
Shannong8355	I-RS	24	50.8	343
	I-RL	44	46.2	361
	R-CK	43	44.9	319
	R-RS	23	45.9	308
	R-RL	39	40.3	312
济南 17	I-CK	30	41.5	612
Jinan17	I-RS	16	42.6	615
	I-RL	29	39.1	607
	R-CK	28	39.4	601
	R-RS	14	39.9	597
	R-RL	26	37.3	594

1.2 试验设计

试验设节水灌溉(全生育期内浇冬水、拔节水和灌浆水,每次灌溉量为 750 m^3·hm^{-2}, Irrigated cultivation, I)和旱作(全生育期不浇水, Rainfed cultivation, R)两种栽培方式。两品种于抽穗后设置 3 个源库关系调节处理,即对照(CK)、减库(去 1/2 小穗,去除穗轴一侧小穗,Removal of 1/2 spikelets, RS)、减源(去除旗叶, Removal of flag leaf, RL)。小麦生育期内各月份的降雨量列于表 2。

表 2 小麦生长期间的降雨量(mm)

Table 2 The rainfall during wheat growth

时间 Time	上旬 The first ten days of a month	中旬 The second ten days of a month	下旬 The last ten days of a month	合计 Total
2006-10	1.7	2.5	2.9	7.1
2006-11	0	5.4	0	5.4
2006-12	0	0	4	4
2007-01	0	0	4.7	4.7
2007-02	4.1	0	3.8	7.9
2007-03	0	0	0	0
2007-04	12.1	1.8	8.9	22.8
2007-05	48.7	4.9	13.6	67.2
2007-06	0.6	20.2	29.9	50.7

1.3 取样方法

于开花期在各处理选择开花、生长一致的穗挂牌,于灌浆中期(花后 15 d)、成熟期分别取样,每小区每次取 30 穗,保存于 -40℃冰箱,用于淀粉粒径测定、分析。

1.4 淀粉粒提取及测定方法

取 5.0 g 小麦籽粒浸泡在 40 ml 蒸馏水中 16 h,在研钵中研磨,匀浆用 200 目筛布过滤,固体部分继续研磨过滤,重复 3 次。淀粉匀浆在 3500g 离心 5min,去掉上清夜,加入 5ml 2mol/L NaCl,旋涡混合,匀浆再离心,同样方法用 2% SDS 和蒸馏水清洗,重复 4 次,丙酮清洗 1 次,然后风干,贮存于 -20℃处。

淀粉粒分析用贝克曼库尔特公司的 LS 13320 激光衍射粒度分析仪测定。

2 结果与分析

2.1 淀粉粒体积分布

小麦灌浆中期及成熟籽粒淀粉粒的粒径在 0.37 ~52.63μm 之间变化。淀粉粒总体积的绝大部分(92.48% ~99.07%)是由 <30.1μm 的淀粉粒组成,仅有 0.93% ~7.52% 的体积来自 30.1 ~47.67μm 的淀

粉粒(表 4)。

B 型淀粉粒(<9.8μm)成熟期济南 17、山农 8355 各处理对总体积的贡献分别为 24.13% ~34.12%、18.08% ~26.35%,较灌浆中期 25.48% ~36.51%、24.60% ~33.35%均有所下降。灌溉栽培条件下,山农 8355、济南 17 成熟期减源处理 B 型淀粉粒体积分布百分比较同品种对照降低幅度均大于灌浆中期减源处理的降幅。山农 8355、济南 17 成熟期减库处理 B 型淀粉粒体积分布百分比较同品种对照提高幅度均大于灌浆中期减库处理的增幅。旱作条件下,山农 8355、济南 17 成熟期减源处理 B 型淀粉粒体积分布百分比较同品种对照降低幅度均小于灌浆中期减源处理的降幅。山农 8355、济南 17 成熟期减库处理 B 型淀粉粒体积分布百分比较同品种对照提高幅度均小于灌浆中期减库处理的增幅。

表 3　灌溉与旱作栽培条件下小麦灌浆中期籽粒淀粉粒的体积分布(%)

Table 3　Volume distribution of grain starch granule in medium stage of grain filling under both irrigated and rainfed conditions

品种 Cultivar	处理 Treatment	淀粉粒径 Particle diameter of starch granule (μm)				
		<2.0	<9.8	2.0~9.8	<30.1	>9.8
山农 8355 Shannong8355	I-CK	9.21Aa	32.55Ab	23.34Bb	99.86Aa	67.45Ee
	I-RS	8.99Abb	33.35Aa	24.36Aa	99.88Aa	66.65Ef
	I-RL	8.86Bb	30.37Bc	21.51Cc	99.74Aab	69.63Dd
	R-CK	8.15Cd	26.57De	18.42Ee	98.26Bc	73.43Bb
	R-RS	8.34Cc	28.49Cd	20.15Dd	99.54Aab	71.51Cc
	R-RL	7.87De	24.60Ef	16.74Ff	99.32Ab	75.40Aa
济南 17 Jinan17	I-CK	9.44ABb	34.58Bb	25.14Bb	99.93BCb	65.41Ee
	I-RS	9.60Aa	36.51Aa	26.91Aa	99.97Aba	63.39Ff
	I-RL	9.25BCc	32.59Cc	23.34Cc	100Aa	67.41Dd
	R-CK	9.19Cc	31.46Ee	22.27Ee	99.92Cb	68.54Bb
	R-RS	9.57Aab	32.23Dd	22.66Dd	99.97Aa	67.77Cc
	R-RL	8.74Dd	25.48Ff	16.74Ff	99.99Aa	74.52Aa

同一列品种内不同大(小)写字母表示 1%(5%)水平下差异显著;下同　Means within a column followed by different capital (small) letter are significantly different at $P < 0.01$ (0.05), the same in following tables

表 4　灌溉与旱作栽培条件下小麦成熟期籽粒淀粉粒的体积分布(%)

Table 4　Volume distribution of grain starch granule in mature grain under both irrigated and rainfed conditions

品种 Cultivar	处理 Treatment	淀粉粒径 Particle diameter of starch granule (μm)				
		<2.0	<9.8	2.0~9.8	<30.1	>9.8
山农 8355 Shannong8355	I-CK	5.56Ee	20.12De	14.56Dec	92.48Ef	79.88Bb
	I-RS	5.88Dd	21.75CDd	15.87CDc	94.48Cd	78.25BCc
	I-RL	5.38Ff	18.08Ef	12.70Ed	93.43De	81.92Aa
	R-CK	6.48Bb	25.05Ab	18.56ABab	95.96Bb	74.95De
	R-RS	6.69Aa	26.35Aa	19.86Aa	97.04Aa	73.45Ef
	R-RL	6.17Cc	23.49BCc	17.32BCc	95.09Cc	76.51CDd
济南 17 Jinan17	I-CK	6.79Bb	33.38Bb	26.59Ab	98.54Aba	66.62Ee
	I-RS	7.44Aa	34.12Aa	26.68Aa	98.13ABb	65.90Ff
	I-RL	6.76Bbc	28.59Dd	21.83Cd	97.03Cc	71.41Cc
	R-CK	6.64Bc	28.35Ee	21.71De	98.26Ab	71.65Bb
	R-RS	6.43Cd	29.34Cc	22.91Bc	99.07Aa	70.66Dd
	R-RL	6.39Cd	24.13Ff	17.74Ef	98.04BCc	75.87Aa

A 型淀粉粒(>9.8μm)成熟期山农 8355、济南 17 各处理对总体积的贡献为 73.45% ~81.92%、65.90% ~75.87%,较灌浆中期 66.65% ~75.40%、63.39% ~74.52%均有所增加,山农 8355 增加的幅度明显高于济南 17。两种栽培条件下,山农 8355、济南 17 成熟期减源处理 A 型淀粉粒体积分布百分比较同品种对照增加幅度均小于灌浆中期减源处理的增幅,山农 8355、济南 17 成熟期减库处理 A 型淀粉粒体积分布百分比较同品种对照下降幅度均大于灌浆中期减库处理的增幅。

以上结果表明,多穗型品种济南 17 籽粒 B 型淀粉粒所占体积比较高,大穗型品种山农 8355 的 A 型淀粉粒体积百分比较高;与灌溉栽培相比较,旱作栽培能提高小麦籽粒 B 型淀粉粒的体积百分比,降低 A 型淀粉粒的体积百分比;源库调节对大穗型品种山农 8355 籽粒各粒径淀粉粒体积分布的影响大于对多穗型品种济南 17 的影响。

2.2 淀粉粒的数目分布

大穗型品种山农 8355 籽粒 A、B 型淀粉粒数目百分比受灌溉调控及源库调节的影响比多穗型品种济南 17 明显(表 5、表 6)。

表 5 灌溉与旱作栽培条件下灌浆中期小麦淀粉粒数目分布(%)

Table 5 Number distribution of grain starch granules in medium stage of grain filling under both irrigated and rainfed conditions

品种 Cultivar	处理 Treatment	淀粉粒径 Particle diameter of starch granule (μm)				
		<1.0	<2.0	<9.8	2.0~9.8	>9.8
山农 8355 Shannong8355	I-CK	66.53Bc	93.99ABb	99.46Aab	5.47Bb	0.54Bbc
	I-RS	70.05Aa	94.45Aa	99.78Aa	5.33Bb	0.22Bc
	I-RL	65.80BCb	93.58BCc	99.31Ab	5.74ABb	0.69Bb
	R-CK	63.20Dc	93.02Dd	99.31Ab	6.29Aa	0.69Bb
	R-RS	68.68Aa	94.11Aab	99.46Aab	5.35Bb	0.54Bbc
	R-RL	63.91CDc	93.43CDc	98.07Bc	4.64Cc	1.93Aa
济南 17 Jinan17	I-CK	76.52ABb	96.39ABb	99.81Bbc	3.42BCc	0.19Bbc
	I-RS	79.26Aa	96.65Aa	99.84Aa	3.19Cd	0.16Cd
	I-RL	65.40Cc	95.63Dd	99.73Cd	4.10Aa	0.27Aa
	R-CK	76.10Bb	96.13BCc	99.80Cd	3.68Bb	0.20Bb
	R-RS	77.04ABb	96.23BCbc	99.82ABb	3.59Bbc	0.18BCc
	R-RL	67.18Cc	96.09Cc	99.72Cd	3.63Bb	0.28Aa

表 6 灌溉与旱作栽培条件下成熟期小麦淀粉粒数目分布(%)

Table 6 Number distribution of grain starch granules in mature grain under both irrigated and rainfed conditions

品种 Cultivar	处理 Treatment	淀粉粒径 Particle diameter of starch granule (μm)				
		<1.0	<2.0	<9.8	2.0~9.8	>9.8
山农 8355 Shannong8355	I-CK	53.87ABbc	93.68Cd	99.72Dd	6.04Aa	0.28Bb
	I-RS	54.87Aab	94.25Bb	99.74Ab	5.49Bc	0.26Ded
	I-RL	56.04Aa	93.95BCc	99.71Ee	5.76Abb	0.29Aa
	R-CK	51.05Dd	94.39Bc	99.74Bb	5.35 Bbc	0.26Dd
	R-RS	53.44BCc	94.60Aa	99.75Aa	5.15Cd	0.25Ee
	R-RL	52.47CDcd	94.14Bbc	99.73Cc	5.60 ABb	0.27Cc
济南 17 Jinan17	I-CK	56.73Ff	93.62Df	99.62Ab	5.99Aa	0.38Cc
	I-RS	79.11Bb	95.88Bb	99.87Aa	3.99BCc	0.14Cd
	I-RL	69.47Cc	95.22Cc	99.33Bc	4.11Bb	0.67Bb
	R-CK	61.21Ee	95.39Bc	99.20Bc	3.18 Cd	0.80Bb
	R-RS	80.77Aa	96.63Aa	99.77Aab	3.14De	0.23Ccd
	R-RL	65.14Dd	94.16De	98.72Cd	4.56Aa	1.28Aa

源库关系改变后山农 8355 成熟期籽粒 <1μm 的淀粉粒数目大约占总淀粉粒数的 51.05% ~56.04%,较灌浆中期 63.20% ~70.05% 有明显下降,济南 17 成熟期籽粒 <1μm 的淀粉粒数目百分比较灌浆中期变化不明显,但是济南 17 各处理 <1μm 的淀粉粒数目百分比明显大于同期山农 8355 各处理。源库关系改变后山农 8355、济南 17 成熟期籽粒 <9.8μm 的淀粉粒数目百分比较灌浆中期变化均不明显。源库关系改变后山农 8355 灌浆中期籽粒 >9.8μm 的淀粉粒数目百分比高于济南 17,而山农 8355 成熟期籽粒 >9.8μm 的淀粉粒数

目百分比低于济南 17。结合表 1、表 2 结果可以看出,尽管小淀粉粒所占体积对总体积的贡献较小,但小淀粉粒是淀粉粒的主要组成部分,这可能是造成两品种籽粒 A、B 型淀粉粒数目百分比变化不明显的主要原因。

2.3 淀粉粒的表面积分布

两品种在灌溉与旱作栽培条件下表现趋势为,A 型淀粉粒减源处理较同期同品种对照处理的表面积分布百分比显著提高,减库处理较同期同品种的对照处理明显降低,B 型淀粉粒表面积分布的变化趋势与其相反(表 7、表 8)。

表 7 灌溉与旱作栽培条件下灌浆中期小麦淀粉粒表面积分布(%)

Table 7 Surface area distribution of grain starch granules in medium stage of grain filling under both irrigated and rainfed conditions

品种 Cultivar	处理 Treatment	淀粉粒径 Particle diameter of starch granule (μm)				
		<2.0	<9.8	2.0~9.8	<30.1	>9.8
山农 8355	I-CK	43.43BCc	74.79Ab	31.37Aa	99.81Aab	25.21Ee
Shannong8355	I-RS	45.11Aa	75.55Aa	30.44BCb	99.97Aa	24.45Ef
	I-RL	44.15Bb	73.93Bc	29.78Cc	99.88Aab	26.07Dd
	R-CK	43.27Cc	71.65De	28.38Dd	99.67Ab	28.36Bb
	R-RS	41.60De	72.82Cd	31.22Aba	99.91 Aab	27.18Cc
	R-RL	42.64Cd	70.06Ef	27.42Ee	99.86Aab	29.94Aa
济南 17	I-CK	48.21Bb	76.12Bb	27.10Aa	99.99Aa	23.88Ee
Jinan17	I-RS	48.69Aa	77.35Aa	27.33Aa	99.99Aa	22.65Ff
	I-RL	46.83Dd	74.39Ee	24.46Cc	100Aa	25.21Cc
	R-CK	48.08BCb	74.51Dd	26.42Bb	99.99Aa	25.50Bb
	R-RS	47.67Cc	74.93Cc	27.26Aa	99.99Aa	25.07Dd
	R-RL	46.95Dd	68.82Ff	21.87Dd	99.99Aa	31.18Aa

表 8 灌溉与旱作栽培条件下小麦成熟期淀粉粒表面积分布(%)

Table 8 Surface area distribution of grain starch granules in mature grain under both irrigated and rainfed conditions

品种 Cultivar	处理 Treatment	淀粉粒径 Particle diameter of starch granule (μm)				
		<2.0	<9.8	2.0~9.8	<30.1	>9.8
山农 8355	I-CK	38.58Ef	65.72Ee	27.14Bbc	97.51Cd	34.28Bb
Shannong8355	I-RS	39.82Cd	66.69Dd	26.87Bc	98.65Bc	33.31Cc
	I-RL	38.98De	63.75Ff	24.77Cd	97.96Cd	36.25Aa
	R-CK	40.47Bb	69.84Bb	29.37 Aa	99.31Aa	30.16Ee
	R-RS	41.21Aa	70.76Aa	29.55Aa	98.96Ab	29.24Ff
	R-RL	40.18BCc	67.63Cc	27.44Bb	98.72Bbc	32.37Dd
济南 17	I-CK	40.33CDc	75.41Bb	35.78Bb	99.86Aa	24.59Ee
Jinan17	I-RS	38.79Ed	76.03Aa	38.56Aa	99.74ABa	23.98Ff
	I-RL	39.92Dc	71.29Ee	34.87Cc	98.50Cc	28.71Bb
	R-CK	41.09BCc	72.23Dd	31.14Dd	99.61Aba	27.77Cc
	R-RS	42.61Aa	73.51Cc	30.90Dd	99.41Bb	26.49Dd
	R-RL	41.51Bb	68.47Ff	27.96Ee	98.58Cc	31.53Aa

灌溉条件下,源库处理后山农 8355、济南 17 A 型淀粉粒表面积百分比分别在 24.45% ~36.25%、22.65% ~28.71%之间变化,B 型淀粉粒表面积百分比分别在 63.75% ~75.55%、71.29% ~77.35%之间变化。旱作条件下,源库处理后山农 8355、济南 17 A 型淀粉粒表面积百分比分别在 27.18% ~32.37%、25.07% ~31.53%之间变化,B 型淀粉粒表面积百分比分别在 67.63% ~72.82%、68.47% ~74.93%之间变化。表明大穗型小麦 B 型淀粉粒所占表面积较低,多穗型小麦 B 型淀粉粒所占表面积较高。

3 讨论

小麦籽粒淀粉粒分布是淀粉品质的重要决定因素之一[23,24]。小麦籽粒淀粉粒度分布因品种基因型而

异,同时,环境条件对其有显著影响[25~28]。高温导致 B 型淀粉粒数目的减少,A 型淀粉粒所占的比例增加[29]。在不同生长条件下,小麦 A 型淀粉粒体积的变化范围为 1.5 倍,而 B 型淀粉粒为 2 倍,即 B 型淀粉粒对环境较为敏感,更容易发生变化[30, 31]。而其它环境因子对淀粉粒特性的影响,尚未见报道。本研究认为,与灌溉栽培相比较,旱作栽培一般能提高小麦 B 型淀粉粒的体积和表面积百分比,而 A 型淀粉粒则显著降低。表明旱作栽培能导致小麦籽粒 A、B 型淀粉粒的体积和表面积百分比发生明显改变。但两种栽培条件对 A、B 型淀粉粒的数目百分比没有明显影响,这可能是由于小淀粉粒($<2.0\mu m$)数目较多,占淀粉粒总数目 93.05% ~96.65% ,受不同灌溉条件调控的影响较小造成的。

不同小麦品种源库关系改变后,由于光合器官间的互相补偿能力不同,籽粒灌浆过程对源库关系改变的反应差异较大。王振林[32]等研究认为,去掉旗叶后,有些品种粒重下降较多,有些下降较少;减少小穗数后,有些品种粒重增加较多,有些增加较少。Blad S. F[33]认为,减少小穗数后,大粒品种的粒重比小粒品种增加的百分率更高。由此可见,不同类型小麦品种对源库关系变化的反应不尽一致。这种差异可能是引起本试验条件下山农 8355、济南 17 籽粒淀粉粒粒度分布因环境变化而表现不同的重要原因之一。

本研究表明,在灌溉和旱作栽培条件下,两种穗型品种济南 17 和山农 8355 籽粒淀粉的粒度分布均受源库调节所影响。品种间比较,在多穗型济南 17 籽粒中 B 型淀粉粒所占体积比较高,而大穗型山农 8355 的 A 型淀粉粒体积百分比较高。灌溉与否和源库关系改变对大穗型品种山农 8355 淀粉粒度分布的调节效应显著大于对多穗型品种济南 17 的调节效应。

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