穴盘育秧播种装置的设计

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摘 要: 根据水稻抛秧要求, 研制了适用穴盘育秧的播种装置, 介绍了它的工作原理和排种胶带的设计, 经试验得出该装置较优设计方案, 在较优的设计参数下, 选出适合精少量穴盘播种的最佳因素组合, 使其播种性能最佳。

关键词: 穴盘育秧; 排种胶带; 充种; 投种
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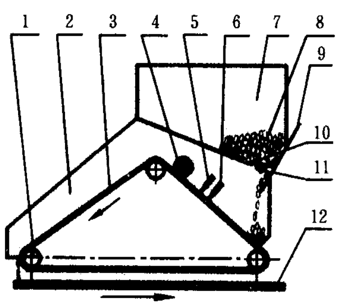
1 结构及工作原理

如图1所示, 种子由种子斗经振动板和闸门之间隙均匀进入种子腔后落在排种胶带上, 随着排种胶带的移动和滚动毛刷、摆动毛刷、移动毛刷的作用, 使种子落入排种胶带的型孔内, 随胶带的转动, 种子在胶带上的位置逐步降低, 最后投入在移动的穴盘穴内。



1. 驱动滚筒 2. 侧板 3. 排种胶带 4. 滚动毛刷 5. 摆动毛刷 6. 移动毛刷 7. 种子斗 8. 种子 9. 闸门 10. 振动板 11. 凸轮 12. 穴盘

图1 穴盘育秧播种装置结构示意图

Fig. 1 Schematics of the structure of device for raising seeding and seeding in aperture disk

2 排种胶带的设计

1) 型孔的几何尺寸及排列方式选择

型孔的几何尺寸是根据种子几何尺寸、播量的大小及每个型孔应容纳的种子数来设计, 按照杂交稻要求, 以2粒/穴为基准来设计型孔, 依据穴盘孔大小及排列方式确定胶带上型孔的位置及排列方式, 经多种型孔试验表明, 以一孔容一粒种子为最佳, 型孔的排列方式如图2所示。

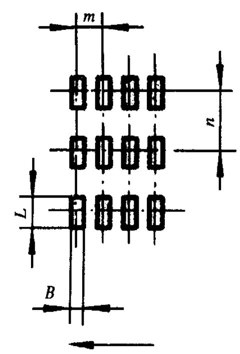


图2 型孔排列方式

Fig. 2 Arraying pattern of molding holes

图中, 尺寸 m、n 由穴盘的穴孔大小及排列形式决定, 型孔长度 $L = 6$ mm, 型孔深度 $H = 3$ mm, 型孔宜一次性成形, 略有坡口, 以便充种和排种。

2) 排种胶带的定位(防止跑偏)

胶带的定位使用两种方法: 一是胶带两侧安装侧板; 二是胶带上设计梯形凸筋。其尺寸与三角胶带(A型)一致, 滚筒上设计了凹槽, 同时胶带两侧设计了侧板, 这样较好解决了定位问题。

3) 胶带的线速度

胶带的线速度与穴盘运行线速度一致。

穴盘的运行线速度为 $v = \frac{Q \cdot L}{3600}$ (m/s)

式中 Q —— 生产率, 盘/h; L —— 秧盘长度, m。

4) 充种性能

胶带型孔充种因孔小而往往不能一次充种成功, 本装置中种子经过自然落粒充种→横向往复移动毛刷充种→纵向摆动毛刷充种→滚动毛刷充种四过程, 可达到良好的充种效果。如果没有移动和摆动毛刷充种, 其播种的各项性能极差, 不能满足生产需要。

3 试验

1) 试验条件: 种子品种为杂交稻(协优46号),

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经脱芒、浸种、催芽露白、去杂质; 种子千粒重为26.9 g; 秧盘规格: 600mm ×340mm , 561 穴。

秧盘运行线速度与排种胶带线速度严格一致。

试验数量: 100 盘。

2) 试验因素

为研究生产率、播种量及投种高度对播种性能的影响, 安排了三因素三水平的正交试验, 试验因素与水平因素见表 1。

表 1　因素水平表

Table 1　Factors and levels of the experiment

水平	A 生产率ö盘·h^{-1}	B 播量大小	C 投种高度ömm
1	300	小	50
2	350	中	100
3	400	大	150

3) 正交试验方案与试验结果

选用 $L_9(3^4)$ 正交表进行试验设计, 试验方案与试验结果见表 2。

表 2　正交试验方案与试验结果

Table 2　The orthogonal experiment plan and experimental results

试验号	A 生产率ö盘·h^{-1}	B 播种量ö粒·穴$^{-1}$	C 投种高度ömm	试验结果		
				播种合格率ö%	播量变异系数ö%	空穴率ö%
1	1(300)	1(1～3)	1(50)	92.0	2.4	4.2
2	1(300)	2(2～6)	2(100)	91.0	4.0	4.5
3	1(300)	3(3～8)	3(150)	88.0	5.2	4.8
4	2(350)	1(1～3)	3(150)	86.0	7.8	5.8
5	2(350)	2(2～6)	1(50)	94.0	2.3	2.5
6	2(350)	3(3～8)	2(100)	90.0	2.6	4.5
7	3(400)	1(1～3)	2(100)	87.0	6.2	7.1
8	3(400)	2(2～6)	3(150)	84.0	5.7	6.5
9	3(400)	3(3～8)	1(50)	92.0	2.5	1.5

数据采集方法: 在每种工况(每个试验号)条件下进行随机抽样 5 盘测定(测定播种合格率和空穴率时, 每盘随机连片抽样 100 穴), 5 次测定的各项数据平均值记入试验结果。

4) 试验结果分析如表 3、图 3。

表 3　试验结果分析

Table 3　Analysis of the experimental results

T[3] 值	播种合格率ö%[3]			播量变异系数ö%[3]			空穴率ö%[3]		
	A	B	C	A	B	C	A	B	C
T_1	271.0	265.0	278.0	11.6	16.4	7.1	13.3	17.1	8.2
T_2	270.0	276.0	271.0	12.7	12.0	12.8	12.8	13.5	16.1
T_3	263.0	270.0	268.0	14.4	11.2	18.7	15.1	10.8	17.1
t_1	90.3	88.3	92.7	3.9	5.5	2.4	4.4	5.7	3.7
t_2	90.0	89.7	90.3	4.2	4.0	4.3	4.2	4.6	5.4
t_3	87.8	90.0	89.3	4.8	3.7	6.2	5.0	3.5	5.7
极差 R[3]	2.6	1.7	3.4	0.9	1.8	3.8	0.8	2.1	2.0
分析较优水平	A_1	B_2	C_1	A_1	B_3	C_1	A_2	B_3	C_1
主次因素			CAB		CBA		BCA		

3 T 为因素试验结果之和, 如: $T_1 = 92.0 + 91.0 + 88.0 = 271.0$

3 t 为因素A 试验结果之和的均值, 如: $t_1 = 271ö3 = 90.3$　R 为 t 值中的大数 — 小数

播种合格率: 每盘随机测定的 100 穴, 其中种子粒数合格的穴数所占的百分比(种子粒数合格范围为: 杂交稻 1～ 3 粒ö穴, 常规稻 3～ 6 粒ö穴)。

变异系数 $V = \frac{s}{X} \times 100\%$　$S = \sqrt{\frac{\sum (x - X)^2}{n - 1}}$

x —— 每盘播种量; X —— 平均每盘播种量; n —— 试验盘数。

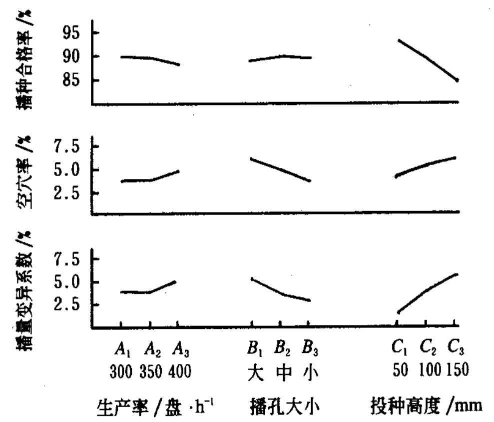

图 3 试验因素与各试验指标的关系

Fig. 3 The relationship between experimental factors and indexes

由表 2 可知: 播种合格率最高的组合为$A_2B_2C_1$; 播量变异系数最低的组合为$A_2B_2C_1$; 空穴率最低组合为$A_3B_3C_1$。

由表 3 和图 3 得出影响 3 项指标的主次因素和较优水平为: 播种合格率 $C_1A_1B_3$; 播量变异系数 $C_1B_3A_1$; 空穴率 $C_1A_2B_3$。

经综合分析及水稻播种实际需要, 各试验因素的较优水平组合选取$A_2B_1C_1$、$A_2B_2C_1$、$A_2B_3C_1$, 在上述正交试验中未出现过$A_2B_1C_1$, 为此专门安排了单因素(播量) 三水平试验, 试验结果见表 4。

表 4 单因素(播量)三水平试验结果

Table 4 The experimental results of single factor at three levels

结构组合	播种合格率ö%	播量变异系数ö%	空穴率ö%
$A_2B_1C_1$	92.0	3.7	3.0
$A_2B_2C_1$	94.0	2.3	2.5
$A_2B_3C_1$	95.0	1.8	0.5

从表 4 可知, 最佳组合为$A_2B_3C_1$, 播种合格率 95%, 播量变异系数为 1.8%, 空穴率为 0.5%。

5) 试验结论

(1) 生产率为 100 盘öh 是该播种装置杂交稻播种的临界生产率, 高于此值, 则各项性能指标受重大影响。

(2) 投种高度对播种质量影响十分显著, 投种高度愈低, 播种质量愈好。

(3) 播量愈大或生产率愈低, 各项性能指标愈好。

4 结 语

经结构设计和试验表明: 排种胶带及其型孔形式设计合理, 胶带的定位可靠, 应用多种辅助机构充分充种, 较低的投种高度和合理的生产率, 使型孔胶带排种器可实现杂交稻穴盘育秧的精量播种。

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pneumatic precision planter is carried out and a mathematical model for seed motional locus is established based on which the operation process for plastic film mulch dibbling function is simulated dynamically by use of computer simulation technology, the influence of the change of implement forward speed, seed drop2off2angle and the bias angle of seed receiving funnel on the seed metering accuracy is found out and the relevant parameters are optimized. The results of this research can be taken as a reference for the design of similar implements.
Key words: computerized simulation; pneumatic planter; plastic film mulch planter; seed metering device

Adaptability Test and Key Technology Research on Conservation Tillage ·············· (78)

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Abstract: Around the sustainable develepment of dryland farming, it has been testing and researching for a long period in the world. The advanced Australian conservation tillage method was introduced in 1991, and was tested in Shanxi Province experimental plots. The test showed that: the conservation tillage has the comprehensive profits of conserving water, improving soil, increasing production and income, and improving ecological envionment. But the planting quality is not so good, which held back further test. Although it can increase the adaption by improving the machine, when the stalk covering rate reaches 80%, a series of problems would appear, e. g. in winter, it is difficult to prevent wind and fire; in spring, the soil temperature goes up slowly, and it is difficult to clean the weeds growing in the crops. By the further test, shallow rotary tillage or shallow harrow of the surface soil, can solve all the problems. Stalk covering, surface soil shallow tillage, and stubble planting make up the matured technical system of conservation tillage method.
Key words: dryland; conservation tillage; surface tillage; sustainable development

Design of Device for Raising Seedling and Seeding in Aperture Disk ····················· (82)

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Abstract: According to demands for rice seedlings throwing, the device for raising seedling and seeding in aperture disk was designed and developed. Its working principle and design of rubber belt for conveying seeds were mentioned in the paper. The design scheme was superior after tested by experimentation. Under the condition of superior parameters, best factors combination for seeding in aperture disk with small quantity of seeds can be singled out and optimal seeding perfomance of the device can be obtained.
Key words: raising seedling in aperture sisk; rubber belt for conveying seeds; appending seeds; throwing seeds

Research and Development of Portable Apparatus for Power and Fuel Consumption Test of Small Tractors ··· (85)

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Abstract: The paper introduces an intelligent test system for power and fuel consumption test of small tractors. The system was developed by use of the microelectronics and single chip computer interface technique, based on single chip computer AT89C51 and inspecting the shape of signal wave by technique on dynamic display of data, which came from HBR21 type pressure sensor and HY21 type flow sensor. The measurement accuracy of power is ±0.10% (kW). It can measure power and fuel consumption of small tractors continuously, rapidly and accurately.
Key words: engine; power; fuel consumption; single2chip computer; test

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Preliminary Experimental Research on Effect of Aluminized Thermal Screens in Greenhouse