文章编号：1005-0906(2021)04-0083-05 DOI: 10.13597/j.cnki.maize.science.20210412

# 不同玉米品种抗蚜性室内鉴定

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**摘 要**：采用环境气候室人工接蚜虫鉴定和累计蚜情指数($I_{aa}$)评判法,对22份玉米品种进行抗玉米蚜*Rhopalosiphum maidis* Fitch鉴定。结果表明,不同玉米品种的抗蚜性差异显著,在抗性品种上玉米蚜种群数量为负增长,产生的有翅蚜少;在感虫品种上玉米蚜种群数量急剧增长,并伴随大量有翅蚜产生。$I_{aa}$值从高抗蚜品种的1.1到高感品种的31.4。高感或感蚜品种9个,占比41%;中抗和抗蚜品种4个,占比18%;高抗品种9个,占比41%。生产上推广种植面积较大的京科968和先玉335等具有中等抗蚜水平,郑单958等高感蚜虫。

**关键词**：玉米;玉米蚜;抗性鉴定;蚜情指数
**中图分类号**：S435.131 文献标识码：A

## Evaluation of Corn Hybrids for Resistance to the Corn Leaf Aphid

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**Abstract**: Evaluation of corn hybrids for resistance to corn leaf aphid *Rhopalosiphum maidis* Fitch was carried out by artificial infestation with one day aged nymphs at the Walk-in Environmental Chamber. Accumulative aphid index($I_{aa}$) was mainly used to compare resistant levels of 22 commercialized hybrids. The results showed that there were significant differences in performance of resistance to corn leaf aphid among those hybrids. The population density was a drastic decline in the highly resistant hybrids. Meanwhile the mean number of alatae was also significant less. In contrast, the population density was significantly increased and more alatae were developed in the susceptible hybrids. $I_{aa}$s ranged from 0.2 to 45.5 representing highly resistant to highly susceptible. Nine of 22 hybrids were highly susceptible and/or susceptible, which accounted for 41%. Four hybrids were resistant or moderately resistant, and nine hybrids were highly resistant, which accounted for 18 and 41%, respectively. Most widely adapted hybrids such as Jingke968 and XY335 demonstrated moderately resistance, but Zhengdan958 performed highly susceptible. These results will provide valuable information for working out a resistant hybrid-based program for IPM of corn leaf aphid in the corn production.

**Key words**: Corn; *Rhopalosiphum maidis*; Resistance evaluation; Aphid index

玉米蚜*Rhopalosiphum maidis* Fitch是危害玉米的重要刺吸式害虫,广泛分布于全球热带与温带地区[1～3]。其寄主植物种类繁多,不仅包括玉米、高粱、小麦、大麦等禾本科作物,还包括稗草、马尾草等杂草[4,5]。玉米整个生育期都会遭受玉米蚜的危害而减产[6]。玉米苗期,玉米蚜刺吸心叶,造成植株生长不良,严重时死苗[7,8]。蚜虫还是多种病毒的媒介,尤其是有翅蚜在田间转移扩散的同时,还可传播大麦黄矮病毒、玉米矮花叶病毒、玉米红叶病(又称玉米黄矮病)等引起病毒病的流行[9]。穗期玉米蚜危害直接损失最为严重[10],若蚜常聚集于新抽的雄穗及正在灌浆的雌穗上吸食,造成雄穗无法散粉,子粒灌浆不满,甚至出现空壳现象,严重影响玉米产量[11,12],除直接刺吸危害外,其分泌的蜜露污染覆盖在寄主表面诱发“煤污病”,影响光合作用[13]。

近年来,由于气候变化,全球平均温度升高及极端高温事件发生的幅度、频率和持续时间增加[14,15],

录用日期：2020-06-20
基金项目：国家重点研发计划项目“北方玉米化肥农药减施技术集成研究与示范”(2017YFD0201800)
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对生物和生态系统造成显著影响[16]。蚜虫发育起点低,世代历期短,是气候变暖的重要指示种[17]。高温干旱天气日益频发更加重了玉米蚜虫的发生和危害[18,19]。目前生产上可供选择的控制玉米蚜危害以化学防治为主,存在作业难、污染环境等问题。研发高效绿色防治玉米蚜的措施是玉米生产中亟待解决的问题之一。

植物抗虫性利用是既简单易行又经济和环境友好的绿色可持续利用的害虫综合治理基本措施[20,21]。玉米抗蚜性的资源鉴定、抗性遗传学、机理等已有许多报道[22~24]。以选育抗蚜为目标的玉米育种工作有限或少有实施,品种间的抗蚜性存在显著差异[25]。品种抗虫性具有持效性和累积性,即使是中等水平的抗虫性即可显著抑制害虫种群增长,并获得收益[26]。本研究对生产种植的22个玉米品种开展抗蚜性鉴定。通过人工接种玉米蚜,观测玉米蚜发生危害程度,建立可靠稳定的玉米品种抗蚜性鉴定方法,为玉米抗虫品种利用及蚜虫科学有效的综合治理提供参考。

# 1 材料与方法

## 1.1 供试玉米

本研究供试玉米品种共22个单交种,由中国农业科学院作物科学研究所提供。供试玉米品种种植在步入式人工气候室,盆栽。气候室环境为温度25.0℃ ± 1.0℃,相对湿度为(65 ± 5)%、光周期16 L∶8 D h。单粒种植于塑料盆中(直径15 cm,高12 cm),待玉米生长至三叶期[27]用于接虫鉴定。

## 1.2 供试蚜虫

玉米蚜 *Rhopalosiphum maidis* 种群采自中国农业科学院植物保护研究所廊坊实验基地玉米田,在人工培养箱(宁波江南RXZ-500D-LED)用大麦饲养多代后备用。气候箱内环境条件:温度为22℃± 1℃,湿度为60%±5% RH,光周期L∶D=16 h∶18 h。选取1日龄若蚜用于试验。

## 1.3 接虫方法

待玉米生长到三叶期,在每盆玉米苗上接入30头1日龄玉米蚜,并在植株外部套上圆柱形透明塑料筒(直径12 cm,高60 cm),塑料筒底部直接插入盆土中,顶部套上双层纱网避免蚜虫逃逸或迁入。每个品种10株,每5 d调查1次,总共调查6次。记录每株总蚜量及有翅蚜量。

## 1.4 抗蚜性评价方法

不同玉米品种的抗/感蚜水平采用累计蚜情指数(Accumulative aphid index,$I_{aa}$)评价法,即根据所有供试品种平均单株上的蚜虫种群数量为基础,计算各品种相对蚜情指数,作为各品种对玉米蚜的抗/感性评价标准。

$$I_{aa} = 1 + \sum_{i=1}^{m} \frac{n_i}{N}$$

其中,$m$为总调查次数;$n_i$为某一品种第$i$次调查时的单株平均蚜量;$N$为所有供试品种的单株平均蚜量。根据$I_{aa}$,将品种的抗蚜性类型分为5级(表1)。

**表1 玉米抗蚜类型划分标准**

Table 1 Categories of corn resistance to the corn leaf aphid

| 蚜情指数 $I_{aa}$ | 抗性类型 Class of resistant levels |
|---|---|
| 1.0 ~ 2.9 | 高抗 |
| 3.0 ~ 4.9 | 抗 |
| 5.0 ~ 6.9 | 中抗 |
| 7.0 ~ 8.9 | 感虫 |
| ≥9.0 | 高感 |

## 1.5 数据处理与分析

鉴定试验进行两次重复,每次试验,玉米品种的播种采用随机排列,每个品种10株。两次鉴定试验分别统计各品种的$I_{aa}$。根据重复鉴定结果,综合评价各品种的抗蚜性类型。以各品种两次鉴定结果$I_{aa}$的最大值判定品种的抗蚜类型。

# 2 结果与分析

## 2.1 不同玉米品种上玉米蚜种群动态

供试品种接蚜虫后,植株上玉米蚜种群数量总的趋势随时间呈波动上升或下降趋势。浚单28等8个品种接虫后5 ~ 10 d蚜虫种群数量为0或趋近于0;龙垦1808等6个品种缓慢上升,接虫20 d后,蚜虫种群密度急剧增长;其他品种上蚜虫数量持续缓慢增长(图1)。不同玉米品种,玉米蚜种群动态规律不同。

玉米抗蚜性水平不但影响蚜虫种群动态,还影响有翅蚜数量(图2)。对于高感品种龙垦1808,当蚜虫种群数量急剧上升时,伴随的有翅蚜数量也上升;在中抗虫品种先玉335上,蚜虫种群数量下降,有翅蚜数量也随着下降。在高抗或抗蚜品种上有翅蚜数量平均小于0.9。

## 2.2 玉米品种抗蚜性水平

蚜情指数分析结果表明,两次试验结果的重复性非常高。济研118等9个品种均表现为高抗;京科968等4个品种表现为中抗或抗;郑单958一次

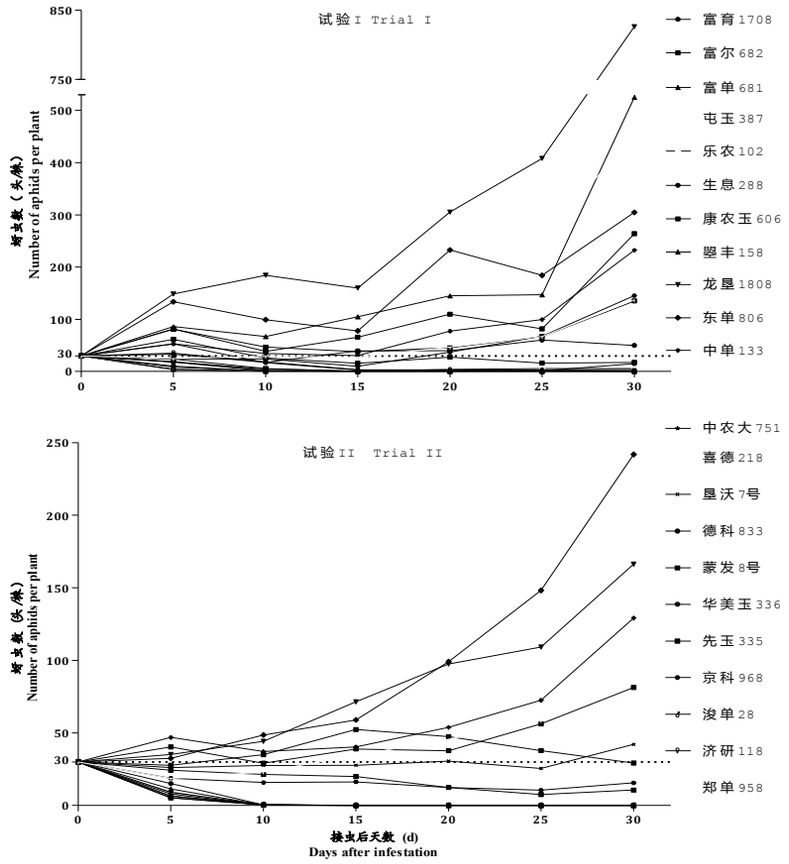


图1　人工接虫后不同玉米品种上蚜虫种群动态

Fig.1　Population dynamics of *Rhopalosiphum maidis* in different corn varieties after artificial infestation

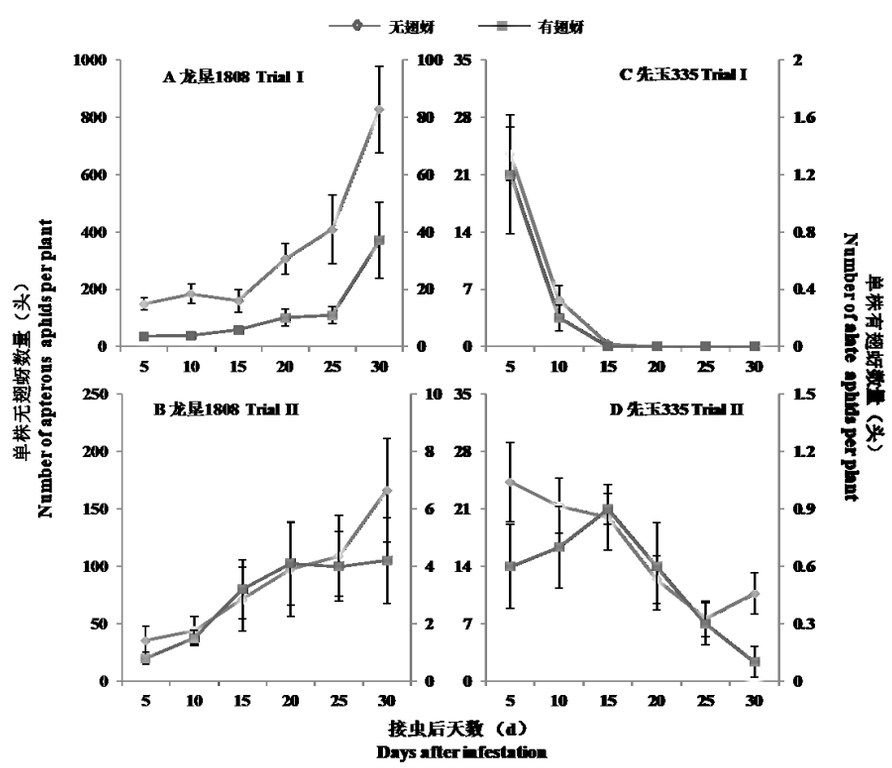


图2　抗/感玉米品种无翅蚜与有翅蚜的种群动态

Fig.2　Population dynamics of apterous and alate aphids on highly susceptible and moderately resistant hybrids

表现为中抗，另一次表现为感虫；龙垦1808等6个品种均表现为感或高感；富单681和垦沃7号的两次试验鉴定结果表现抗性差异较大(表2)。综合两次结果发现，鉴定的22个玉米品种中，高感和感蚜品种占41%，高抗品种占41%，抗和中抗品种占18%。生产上推广面积较大的品种京科968和先玉335属于中等抗蚜虫品种，郑单958属于易感蚜虫品种。

**表2 玉米品种单株平均蚜量**

Table 2 Average of aphids per plant for each corn hybrid

| 品 种 Hybrid | 蚜情指数 $I_{aa}$ | | 抗蚜性等级 Resistance level | 品 种 Hybrid | 蚜情指数 $I_{aa}$ | | 抗蚜性等级 Resistance level |
|---|---|---|---|---|---|---|---|
| | I | II | | | I | II | |
| 龙垦1808 | 31.4 | 22.1 | HS | 先玉335 | 1.7 | 5.6 | MR |
| 屯玉387 | 22.8 | 26.6 | HS | 蒙发8号 | 4.4 | 1.3 | R |
| 东单806 | 17.9 | 22.1 | HS | 济研118 | 2.5 | 1.4 | HR |
| 富单681 | 16.2 | 1.6 | HS | 浚单28 | 1.2 | 1.5 | HR |
| 康农玉606 | 10.7 | 11.7 | HS | 华美玉336 | 1.6 | 1.4 | HR |
| 中单133 | 8.5 | 14.9 | HS | 乐农102 | 1.7 | 1.4 | HR |
| 富尔682 | 8.0 | 10.8 | HS | 中农大751 | 1.6 | 1.4 | HR |
| 郑单958 | 6.0 | 10.9 | HS | 喜德218 | 1.2 | 1.5 | HR |
| 垦沃7号 | 2.8 | 8.3 | S | 德科833 | 1.2 | 1.3 | HR |
| 京科968 | 5.2 | 4.9 | MR | 富育1708 | 1.1 | 1.5 | HR |
| 生息288 | 5.3 | 1.8 | MR | 墨丰158 | 1.1 | 1.5 | HR |

## 3 讨 论

本研究建立室内可大规模人工接虫鉴定玉米抗蚜虫性的精准方法，明确目前国内玉米大面积生产应用的品种京科968和XY335等中等抗蚜性，郑单958等感蚜。

玉米抗蚜性是玉米和蚜虫在长期进化过中的协同关系。评价作物抗蚜性不同，研究者采取不同指标，一是蚜虫参数，包括蚜情指数法[27]、离体生测生命表法、刺吸电位(EPG)法[28]等；二是玉米生长参数，包括测定光合指标与生物量变化[29]，以被害状为抗性指标[30]等。EPG法通过实验室测定蚜虫在不同玉米品种上不同取食波形来评价品种抗蚜性，对研究植物抗虫机理奠定了基础。由于玉米蚜个体较小，实验操作相对复杂，不适合在种质资源鉴定和抗性品种选育中应用。同样，离体生测生命表法观测和比较的处理(品种数)有限。玉米光合指标与生物量法、田间自然虫量下的虫情指数以及玉米被害程度法为抗性品种的筛选提供一定的数据参考。由于田间环境多变、干扰因素复杂且不易控制，自然虫量的均匀性和稳定性差异显著，对玉米抗蚜性的鉴定结果有较大影响。采用室内精准接虫鉴定和蚜情指数评判法，通过蚜虫种群数量变化，反映蚜虫对植物品种的自然选择和品种的抗蚜性强弱，既排除环境因素的干扰，又易于操作，可用于开展大量种质资源和品种选育筛选鉴定。

玉米品种抗性直接影响蚜虫种群动态，还间接影响有翅蚜数量。感虫品种蚜虫繁殖快，密度上升也快。高密度易诱发种群产生有翅蚜，感虫品种有翅蚜数量多，抗虫品种有翅蚜数量低。有翅蚜和更为精准的感觉系统，善于飞行与寄主定位，对恶劣环境有更强的适应性[31]。有翅蚜也是玉米矮花叶病的主要传毒媒介，田间玉米矮花叶病的病株率与苗期有翅蚜高峰期和种群密度显著相关。利用抗虫品种通过防治蚜虫苗期危害是阻断玉米矮花叶病流行传播的重要途径。

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