EFFICIENT CROSSING TECHNIQUES IN OATS (AVENA SATIVA L)

A. NIRMALAKUMARI, G. THAMODARAN, R. SELLAMMAL, T. EZHILARASI & R. RAVIKESAVAN

Department of Millets, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore, India

ABSTRACT

Efficient crossing techniques were tried to improve the seed set of several oats accessions namely UFRGS 078030-2, URS GURIA, URS TARIMBA, URS/GUAPA, URS 22, UFRGS 077026, URS-TORENA under field conditions. Crossing work was carried out for two different intervals. Seed setting percentage recorded for pollination with prior to anthesis was on an average 42 per cent. Highest seed setting was reported in GUAPA X GURIA cross combination, it was recorded 70 per cent seed setting. Lowest one was URS 22 X FAPA cross recorded only 10 per cent seed setting. Reduction in seed setting was reported in delayed pollination, it was revealed that delayed pollination considerably reduce the pollen viability and stigma receptivity. Seed setting per cent for pollination with one day after anthesis was only 18 per cent. So it was concluded that over 24 % more seed setting was achieved by following the early stage pollination. It was also reported that temperature and moisture have profound effect on seed setting, pollen viability and stigma receptivity, optimum temperature is required for anthesis and seed setting.

KEYWORDS: Genotypes, Emasculation, Anthesis, Pollination, Pollen Viability and Stigma Receptivity

INTRODUCTION

Oats rank sixth among cereals in world production, following maize, rice, wheat, barley, sorghum and the millets. Currently, commercially available oats cultivars belong to the hexaploid species Avena sativa and Avena byzantina. Avena byzantina, also known as red oat, is close to Avena sativa L. Oats is a cereal crop and is used for human food and livestock feed worldwide (Peterson et al., 2005; Achleitner et al., 2008). As compared to the other cereal crops, oat is broadly adapted to marginal environments with low fertility soils, cool-wet and low rainfall climates (Hoffman 1995; Buerstmayr et al., 2007; Ren et al., 2007).

Several investigations have observed the existence of heterosis in oats (Rothman and Bowman, 1963). Because oats are autogamous species, researchers working with this crop frequently face the problem of lack of satisfactory amounts of hybrid seeds due to the difficulty in performing crosses in standard methods (Barbosa Neto, 1985).

In this study, attempt have been made to cross several oats genotypes to increase the yield of existing genotypes. Compared to other cereals, crossing in oats was tedious and found to be poor in seed set due to various factors like temperature, moisture, time of emasculation, stigma receptivity and viability of pollen.

Oats is a self pollinated crop classified under chasmogamous species. Inflorescence of oats is a determinate panicle consisting of many spikelets, each of which contains two or three florets. During anthesis, the lodicules in each floret swell after water uptake and cause the lemma to diverge and establish a wide angle between it and the palea. The essential organs in the floret are exposed to the environment and subsequently the anthers dehisce releasing pollen. The pollen grains are dropped on the stigmatic branches, thus effecting self-pollination. Following pollination, the floret closes because of the collapsing of lodicules. The pollen on the stigma germinates after the floret has closed. The ambient temperature range for anthesis in the field is 25-28°C.
Prime objectives of this study were,

- To evaluate the methodology of crossing to increase the seed setting percentage among different genotypes,
- Crossing at two different intervals to standardize the pollination behavior.

MATERIALS AND METHODS

The seeds of eight genotypes were sown in a row with wide spacing during rabi, 2012-2013 at IARI, Regional Research Station, Wellington. The study plot were designed in a Randomized Block Design with three replications. Plants begins to flower from 45 days after sowing. At this time the female parent was created by removing the anthers containing pollen by hand emasculation. Florets were emasculated on one day prior to anthesis. Anthesis in oats begins at 2.00 p.m and was extends up to 6.00 p.m. Emasculation was effected at 4.00 p.m. Emasculated panicle was covered with butter paper cover. In the next day morning the male parent was selected and pollen introduced to the female plant for pollination. The pollen was introduced by placing the individual pollen on the emasculated florets with the use forceps. The panicles were covered with butter paper cover to prevent contamination from foreign pollen. On the cover the data about the date of sowing, date of emasculation, date pollination and Parental lines involved in the cross would be recorded. When pollination is successful, seed develops, which is hand harvested and threshed. This seed represents the first generation known as the F1 or hybrid seed. Percentage of seed setting was worked out for each genotype. Seed setting percentage was worked out as follows,

\[
\text{Seed setting (\%)} = \frac{\text{No of hybrid seed}}{\text{No of florets pollinated}} \times 100
\]

This procedure was followed for two different intervals like (1) pollination immediately after emasculation, (2) pollination one day after emasculation.

CLIPPING METHOD

In the previous day evening, top 1/3rd and bottom 1/3rd portions in the panicle of the desired female parent were clipped off by using pair of scissors leaving in the middle portion of the panicle. With the help of the pair of scissors again, top 1/3rd portion in each spikelet is clipped-off in a slanting position. The six anthers present in each florets are removed with the help of the forceps, these steps formed the emasculation. Care must be taken during emasculation for not to damage the gynoecium. Then to prevent contamination from the foreign pollen, the emasculated florets are covered with a butter paper bag. In the next day morning (usually at 9.00 a.m), the bloomed panicle from the desired male parent is taken. The top portion of the butter paper bag which was originally inserted in the emasculated female parent is now cut to expose the panicle. The panicle from the male parent is inserted in an inverted position into the butter paper bag and sturned in both ways in order to disperse the pollen. After ensuring the abundant disbursement of pollen, the opened butter paper bag is closed using a pin. Colored thread is tied at the base of the panicle to identify the crossed ones. After ensuring pollination, the bag is removed.

RESULTS AND DISCUSSIONS

Crosses were effected among the eight genotypes. On an average ten spikelets per panicle were made in each cross combination. Data on number of seeds per cross and seed setting percentage were worked out for two different time intervals of pollen dusting are presented in Table 1. Pollination at two different time intervals showed variation in seed setting percentage among different oats accessions (Figure 1). Among the two time intervals, immediate pollination after emasculation showed significantly high seed set per cent for different cross combinations. The highest seed set was found
in GUAPA with GURIA cross combination, which recorded 7 seeds with 70 percentage of seed setting followed by TARIMBA with 077026 60 percentage. URS 22 with GUAPA 50 seed set percentage respectively. Lowest seed setting percentage was found in cross 077026 with URS 22, 20 per cent. Average seed setting for pollination prior to anthesis was 42 per cent. Pollination with one day after anthesis found to be considerable reduction in percentage of seed setting 22 %. On an average it recorded around 18 percentage seed setting, it was comparatively lower than that recorded for pollination with prior to anthesis. The present study proved that reason for lower seed setting on delayed pollination was due to innate flower factor and other external environmental factors.

![Figure 1: Steps in Emasculation and Pollination in Oats](image)

Where, Figure 1a. Selection of paents, 1b. Clipping of spikelets, 1c. Removal of anthers, 1d. Emasculated panicle, 1e. Preparation of panicle from the male parent for pollination, 1f. Bagging, 1g. Labeling, 1h. Hybrid seed development, 1h(a). Seed development on pollination with one day after emasculation, 1h(b). Seed development on pollination with immediately after emasculation

<table>
<thead>
<tr>
<th>S.No</th>
<th>Number of Crosses Effected</th>
<th>Pollination with One Day after Anthesis</th>
<th>Pollination Prior to Anthesis</th>
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<tr>
<td></td>
<td></td>
<td>Number Hybrid Seeds</td>
<td>Seed Setting Percentage (%)</td>
</tr>
<tr>
<td>1</td>
<td>077026 X FAPA</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>URS 22 X FAPA</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>GUAPA X 078030-2</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>078030-2 X GURIA</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>5</td>
<td>077026 X GURIA</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>6</td>
<td>GUAPA X 077026</td>
<td>2</td>
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</tr>
<tr>
<td>7</td>
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<tr>
<td>8</td>
<td>077026 X URS 22</td>
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Table 1: Contd.,

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<tr>
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<tr>
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<td>10</td>
<td>2</td>
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<tr>
<td>11</td>
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<tr>
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<td>3</td>
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<td>5</td>
<td>50</td>
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<td>13</td>
<td>TARIMBA X 077026</td>
<td>2</td>
<td>20</td>
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</table>

The previous studies predicted that the variation observed in seed setting at different stages could be attributed to the inherent developmental changes in stigma and embryo sac of the female flowers. The large variation observed in grain setting in silky oat (Kalinganire et al., 2000) was attributed to the changes in stigma and embryo sac structures while in buffelgrass (Shafer et al., 2000) it was due to the protogynous nature of the flower. In oats such studies are needed to understand the role of developmental changes in stigma and embryo sac in seed set. The decline in the seed set rate is attributable to the pollen viability and stigma receptivity of the flower. The results of the present experiment showed that the differences observed in various seed setting efficiency could be attributed to the differences in the methodology and/or the genotypes used in the studies and environmental conditions. From the present study conducted at Wellington, India it is concluded that for maximizing seed set, the pollinations should be initiated immediately after emasculation and be continued for one day after anthesis our results were in accordance with this study. In addition to pollen viability and stigma receptivity many other factors also influenced the seed setting like temperature, moisture and speed of wind etc.

For better hybrid seed set crossing could be initiated immediately after emasculation. Generally oats begins anthesis at 2.00 p.m and extend up to 6.00 p.m. Pollination effect fertilization 15-30 minutes after placing of pollen.

The pollen viability of all the oats genotypes was lower when compared with other cereals but it recorded longer duration of anthesis. In addition to the flower innate factors like pollen viability and stigma receptivity other external factors like temperature and moisture playing crucial role in seed setting. Around 25-28° C temperature was required to better anthesis and fertilization. Too high temperature will inhibit the stigma receptivity and pollen germination. Therefore, high hybrid seed yields in oat might be related to rapid seed filling characteristics, and so the adaptation to the environment might be improved through selection of early flowering genotypes [Redaelli and Lagan, 2008].

CONCLUSIONS

Analysis of eight oats genotypes for their variation in seed setting and anthesis provided an information about pollen viability and stigma receptivity. Pollen viability lost for shorter period, it was evident from seed setting percentage reported for two different pollination intervals. Average seed setting percentage for pollination followed prior to anthesis set record higher, 42 per cent, it was only 18 per cent for pollination with one day after anthesis. Over 24 percent increase in seed setting was recorded while following the pollination prior to anthesis. It was conclude that duration of anthesis reported comparatively higher than other cereals but pollen viability and stigma receptivity was significantly lower.

ACKNOWLEDGEMENTS

The authors here by acknowledge the Regional Research Station, IARI, Wellington for providing the seed material and technical support. The author also thank to MARICO-India Pvt Ltd for providing financial support to carry out the experiment.

REFERENCES


