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Hybridization and Factors Influencing Seed Set in Oat

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ABSTRACT

Background: Oat is mostly neglected crop for hybrid development due to its floral structure which results in high damage rate during hybridisation. Due to the cumbersome in acquiring a sufficient number of hybrids and subsequent backcrosses are difficult that lead to lack of much inheritance studies in Oats.

Methods: The procedure for crossing used was almost identical to that used by oat breeders which was conducted for 2 years *viz*., 2019-20 and 2020-21 at Forage Station, Punjab Agriculrural University, Ludhiana.

Result: The experiment was conducted to know the seed set percent in oat cultivars. Since the oat flower is fragile compared other cereals and it is easily harmed during the emasculation and pollination process. The seed set percent observed was only 12 and 10 percent in the year 2019-20 and 2020-21, respectively.

Key words: Emasculation, Florets, Factors influencing, Hybridisation, Oats, Pollination, Percent seed set.

INTRODUCTION

Oat (*Avena sativa* L.) is a winter cereal crop belonging to genus *Avena* and family graminae (Poaceae). It is originated from Mediterranean region. It is self-pollinated crop having very little diversity (Rana *et al.,* 2019). The genus *Avena* constitutes of around 70 species and the only commercially cultivated species are *A. nuda, A. byzantina* and *A. sativa*. The cultivated oats are allohexaploid with chromosome number 2n=6x=42. Oat ranks sixth in production after wheat, maize, sorghum, rice and barley. Oat breeders have recorded low seed set following hand pollination of both intraspecific and interspecific cross pollinations. Due to the difficulty in acquiring a sufficient number of hand-crossed plants, backcrosses for gene replacement and crosses for inheritance studies have been neglected. The low seed set is likely due to a number of factors. The oat flower is fragile in comparison to other cereals and it is easily harmed during the emasculation and pollination process. Furthermore, seed set per cent influenced by environmental factors is very significant. Some of the factors influencing seed set was studied and the number of crosses made in two years were compared and seed set percentage was recorded Majority of the experiments involving crossing were performed in the field. Scissors and straight-pronged forceps were among the tools used. The procedure was almost identical to that used by oat breeders. Emasculation and pollination were usually separated by 1 or 2 days. In most crosses, only the six to eight uppermost florets were used. Pollen was obtained from mature, yellow, dehiscing anthers; however, the consistency of the pollen differed from day to day due to the weather parameters (Starling, 1980).

Floral biology

The flowers are enclosed in a scales or bracts and grouped in a characteristic structures are called spikelet (Fig 1,2). Spikelet of oat are arranged in a panicle. Each spikelet has a small joints axis or rachilla which bears floret. Within the spikelet the floret are present. Floret may vary from 2 to 3 When it consist of 3 florets, it may consist of a) opened primary floret b) unopened secondary floret c) rudimentary tertiary floret (Fig 3). Blooming begins in the upper floret. Oats has an incomplete flowers because it lacks sepals and petals (Misonoo 1936). Each floret consist of lemma, palea, stamens and stigma and two large glumes. The floral structures are depicted in the Fig 1 to 5.

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MATERIALS AND METHODS

The crossing was carried out for two years 2019-20 and 2020-21 at forage station, PAU, Ludhiana. The amount of seed set was determined. Total of 50 crosses during 2019-20 and 400 crosses during 2020-21 were made and the crossing percentage or seed set percent was recorded. The equipments used during experiment or crossing were dissecting forceps, dissecting scissors, needles, paper clips and cover bags (Include reference here). The method followed for crossing is described below (Nirmalakumari *et al*., 2013).

Procedure

1. Flag leaf sheath was opened by forcing the leaf edges with the help of forceps.
2. Leaf sheath and flag leaf were cut at the level of the first node of the rachis.

3. Then removed lateral florets and tip of the spike.
4. All the anthers were removed with the help of forceps from all the florets. All the florets on the spike were emasculated to prevent self-fertilization.
5. Bagging was done to the emasculated spikes to prevent contamination from foreign pollen.

Steps of pollination

1. Spike having dehising anthers were selected.
2. Top one third of the spikelet was made a cut to expose the anthers. Then anthers were kept inside emasculated florets.
3. Tag with the following information was attached such as Objective, Date of emasculation, Date of pollination and Name of the breeder.

RESULTS AND DISCUSSION

Seed set per cent based on two years observation revealed that seed set for 2019-20 was 12 per cent *viz*., 6 panicles had set seeds out of 50 panicles, whereas 10 per cent in 2020-21 *viz*., 40 panicles out of 400. Each panicle had 8-10 spikelet pollinated and around 350 spikelets were obtained out of 4000 spikelets (Table 1 and 2).

Seed set in artificial hybridization of oats is influenced by a number of factors. Pollen content was often blamed for seed set failures. Immaturity of pollen seems to be the primary cause of low efficiency. To make crosses, only mature anthers with dusty pollen should be used. Pollen seems to be at its best just before natural anthesis. (Hilli and Kapoor, 2021). On some days, suitable pollen is only available for an hour, but on others, it is available for many days. The importance of stigma receptivity was discovered. When 1 to 2 days passed between emasculation and pollination, the highest percentage of seed set was recorded. Pollination preceded emasculation on the same day, or when emasculation and pollination were separated by more than 2-3 days, there was less seed set. At low temperatures, stigmas remained more receptive than at high temperatures.

Fig 1: Flag leaf stage.

Fig 2: Spikelet.

Fig 3: Floral structure.

Fig 4: Bifid stigma.

Fig 5: Anthers.

Table 1: Total number of crosses attempted.

Year	Total number of crosses	Successful crosses	Per cent seed set
2019-2020	50 panicles	12	12
2020-2021	400 panicles	40	10

Table 2: Number of florets pollinated and their seed set.

Year	Total number of florets pollinated	Total florets with seed set
2019-2020	400	48
2020-2021	3000	300

Factors influencing seed set

The number, type and age of florets emasculated, time of day of emasculation and pollination, stigma receptivity, pollen condition and environmental relations play vital role in relation to the success of crossing in small grains. Seed set was favoured by low field temperatures, while seed set was hampered by high temperatures. Seed set was reduced by high temperatures between emasculation and pollination, particularly when the interval was 3 or 4 days. Since there was more pollen available in the afternoon, most pollinations were done in the afternoon, but morning pollinations were effective on some days. Shorter intervals between emasculation and pollination result in more top florets set seed, whereas longer intervals result in more lower florets set seed. Stigma receptivity was most likely a factor. Just 3 or 4 of the uppermost stigma is emasculated on the day of the emasculation. On hot days usually simply opening and closing florets to extract one anther resulted in a 30 to 50% reduction in seed set, but only a 5 to 10% reduction on cool days. Clipping the spikelets partially exposed the primary floret pistils, which decreased seed set significantly on hot days but not so much on cool days (Brown and Shands, 1956).

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