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Hybridization technique in nutritional potential to climate resilient fodder crop oat (*Avena sativa* L.)

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Abstract
Plant breeding has enormous potential to modify crop to produce new outcomes. Earlier, much effort has been devoted to enhance grain yield and improving agronomic as well as desirable characters and resistance to diseases, but, increasingly, breeders have the opportunity to alter chemical and technological qualities to meet new demands. Forage crop i.e., oat have nutritional potential to climate resilient crop. Traditionally, the oat crop (*Avena sativa*) has been neglected in a various respect, it cultivated in those cropping areas where less chance for wheat, barley or maize cultivation. In recent years the interest in oats has increased, particularly due its dietary benefits and therapeutic potential for human health. The oat considered as unique and more advantageous hen the other cereals as it contains valuable nutrients that us useful for human health, due to these it has been studying and reported for it importance as well as opens new markets for the oats. Despite its well-documented benefits, oats are still in a fragile state for a number of reasons. The cultivated area of oats is much smaller compared to other cereals, and therefore there are also smaller investments in oat processing. Lack of visible market competitiveness and some biological disadvantages of oats, including low grain yield, keep oats as a less profitable side crop. So more oats yield and quality improved are need, which is possible through crossbreeding technology.

Keywords: Emasculation, forage crops, hybridization, oat

Introduction
Forage are the connection of both Agriculturist as well as Veterinary field. The development of fodder in the country is required to effectively feed the animals. There is a need to accelerate fodder production and effective use by promoting a comprehensive fodder production, conservation, and utilisation strategy to increase fodder supply throughout the year. Developing backward and forward linkages with multiple stakeholders. Focused research and development in prioritised areas of concern, such as fodder variety, technology, seed production, and feed management. Promotion of opportunities in commercial fodder production and utilisation, development of entrepreneurship in fodder, silage, densified bales, feed pellets, feed block, fodder seed pelleting, and so on. Oat (*Avena sativa* L.) is a winter cereal crop that belongs to the genus Avena and the graminae (Poaceae) family. It is originated from Mediterranean region. It is a self-pollinated crop that has little diverse (Rana *et al*., 2019) [10]. 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. After wheat, maize, sorghum, rice, and barley, oat ranks sixth in terms of production.

Low seed set has been seen in oats after hand pollinating both intraspecific and interspecific cross pollinations. Due to difficulty in acquiring sufficient number of hand crossed plants, backcrossing for gene replace and crosses for inheritance studies havebeen neglected. The low seed set is likely due to a number of factors. The oat blossom is sensitive in comparison to other cereals, and it is readily damaged during the emasculation and pollination processes. Furthermore, seedset 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 experiment involving crosses were performed in field. Scissors and straight-pronged forceps were among the tools used.

Nearly all of the steps were the same as those oat breeders utilised. 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) [11].

Floral Biology

The flowers are arranged in unique arrangements known as spikelets and are encased in scales or bracts. Oat spikelets are arranged in a panicle. Each spikelet has one small joint called an axis or rachilla which bears florets. There are florets inside the spikelet.

Floret may vary from two to three when it consist of three florets, it may consist of

1. Opened primary floret
2. Unopened secondary floret
3. Rudimentary tertiary floret.

Blooming begins in upper floret. Oats have incomplete flowers because they do not have sepals and petals (Misonoo 1936) [8]. Lemma, palea, stamens, stigma, and two large glumes compose each floret.

Material and Methods

The crossing was carried out for 2 years 2021-22 and 2022-23 at forage station, ANDUA &T, Kumarganj, Ayodhya. The amount of seed set was determined. Total of 40 panicles crosses during 2021- 22 and 50 panicles crosses during 2022-23 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 (Nirmala kumari *et al*., 2013) [9]. Fig. A shows the structure of leaf of Oat plant and Fig. B shows Twig of Oat Plant consisting Stamens and Stigma.

Procedure of Hybridization

Using forcep the flag leaf sheath was opened by forcing the leaf edges. The flag leaf and leaf sheath were then clipped at the first rachis node level. The spike's the tip and lateral florets were then removed. Using forceps, all the anthers from each and every floret were removed. All of the florets on the spike were emasculated to prevent self-fertilization, and the emasculated spikes were then bagged to avoid contamination from outside pollen.

Steps of Pollination

First of all Spike having dehising anthers were selected. Then top one third of the spikelet was made a cut to expose the anthers. Then anthers were kept inside emasculated florets. Then tag with the following information was attached such as Objectives, Date of Emasculation, and Date of Pollination & Number of breeder.

Fig A: Leaf of Oat Plant

Fig B: Twig of Oat Plant consisting Stamens and Stigma

Results and Discussion

One of the biggest challenges for the next generation of forage crops is to develop varieties that can resist the negative effects of climate change or adapt to a changing environment. Diverse populations of many forage species are available that can undergo natural selective changes in response to soil acidity, heavy metals, air pollution, salinity, temperature extremes, drought, and many other stressors. For many forage crops, where livestock farmers depend on the vitality of forests, a variety of forage crops should be grown, and the animals will also benefit from healthier and higher quality forage.

Seed set per cent based on two years observation revealed that seed set for 2021-22 was 10 per cent *viz*., 4 panicles had set seeds out of 40 panicles, whereas 12 per cent in 2022-23 *viz*., 20 panicles out of 50. Each panicle had 8-10 spikelet pollinated. 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. Only mature anthers with anther pollen should be used for crossing. Pollen seems to be at its best before natural anthesis. Some day's suitable pollen is only available for an hour, and some days for several 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.

The number, type & Age of florets Emasculated, Time of day of Emasculation & Pollination, Stigma receptivity, pollen condition & environmental conditions play a key role in the success of crossing small grains. Seed set was favoured by low field temperatures, while seed set was hampered by high temperatures. Seed set was reduced by higher temperature 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 on some days, morning pollinations were effective. Shorter intervals among emasculation and pollination result in copious top floret set seed, whereas longer intervals result in 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 thirty to fifty percent reduced in seed set, but only a five to ten percent reductions on cool days. Clipping the spikelets partially exposed the primary floret pistils, which decreased seedset significantly on hot days but not so much on cool days (Brown and Shands, 1956) [2].

Conclusion

Forage crops can be an important tool for producers if the right crop is chosen careful management is necessary to ensure that the crop is fully utilized during its most productive and nutrient-rich growth phase. Pests and diseases must also be dealt with in such a way that their impact on productivity is as small as possible. A well thought out grazing strategy is essential to maximize the production potential of a forage crop. Forage plants can be grown alone for hay or silage production or grazed before the forage is set aside for storage. Both the time of grazing and the mowing of hay or silage are decisive in optimizing the quality and quantity of fodder to be stored.

Crossing Technique is not easy in Oats as well as Chances of seed Set is also very poor. It is tedious job for plant breeder to find variety though hybridization technique. Variation is important factor in plant breeding and need to develop climate resilient varieties to cope up with climate change condition.

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