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Functional pollen ability of different crab apples used as pollinizers for apple

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Abstract
The present study entitled "Functional pollen ability of different crab apples used as pollinizers for apple" was carried out during the year 2014-2015 in Division of Fruit Science SKUAST-K, Jammu and Kashmir. Four crab apple species (Malus floribunda, Golden Hornet, Manchurian and Fenna) and Golden Delicious (control), used as pollinizers in the valley, were studied for functional pollen ability. The experiment was laid in RCBD design with four replications. Among the pollinizers, Malus floribunda was significantly superior from others with the highest pollen viability (99.00%) and pollen germination (63.50%) followed by Golden Hornet (98.75% pollen viability) and (58.50%) pollen germination. The lowest pollen germination percentage of 53.50 was found in Golden Delicious. Highest pollen production per flower was noted in Malus floribunda (123750) and lowest (45000) in Manchurian. Malus floribunda was found best pollinizer among all the crabs.

Keywords: Crabs, viability, pollination, pollinizers, pollen compatibility

1. Introduction
The cultivated apple Mauls x domestic Bork. is an interspecific hybrid complex of allopolyploid origin (Korban and Skirvin, 1984) [4]. The progenitor species is thought to be M. Sieversii. Apple was introduced in the country by British in Kullu valley of the Himalayan State of H.P. as far back as 1865, while the coloured Delicious cultivars of apple were introduced to Shimla hills of the same State in 1917. Apple production is a result of series of physiological events including fruit set (Sanzol and Herrero, 2001) [7]. But one of the pressing problems today is decline in the quality and quantity of apples in the valley. There could be a number of reasons for declining apple production, but the most important which needs a quick attention is proper management for pollination in apples. Pollination is one of the keys to profitable apple production. Therefore it is important to select a pollinizer variety which has compatible pollen and an overlapping flowering period. Apple varieties are generally self-unfruitful and do not fruit by their own pollen due to the antagonism that prevents pollen grains from growing on to stigmas of the same variety. Genetically apples show gametophytic self-incompatibility (Thompson and Thompson, 1992) [10] which necessitates the pollen transfer from another pollinizer variety to set fruit in marketable quantities. For cross pollination to be effective it is very important that the cultivars bloom at approximately the same time, produce the sufficient quantity of viable, compatible pollens. Keeping this in mind Crabs apples serve the purpose and can be considered as best pollinizers, particularly where a second variety is not desired, or the use of another variety will make management of the orchard more complicated. The common pollinizer used in apple orchards is Golden Delicious and Red Gold but it has been reported that these cultivars do not synchronize with Delicious group and bloom late which ultimately results in poor fruit set and quality. Further these pollinizers do not pollinate the king flower of the apple crop which has the inherent potential of producing the high value "A" grade fruit. On the other hand crab apples bloom early and remain blooming for a longer duration. To harness the benefit of early and long blooming period of these crab apples, the functional ability of pollen of different crabs was studied.

2. Materials and Methods
To study *in vitro* functional pollen ability of different crabs and Golden Delicious apple which were grown on M_9 rootstock under same environmental conditions, pollinizer flowers were bagged at balloon stage, anthers collected when the maximum anthers had dehisced. Pollen grains were collected in small vials for further studies.
For testing the pollen viability, pollen grains after collection were dusted on 2% solution of Acetocarmine, which was prepared by taking 2g of Acetocarmine, 45 ml of 95 per cent ethanol and the total volume was made to 100 ml with distilled water. Then pollens were left for

1 hour for staining, based on staining, the percentage of viable and dead pollens were examined under microscope. Deeply stained and normal looking pollen grains were considered as viable while as shrivelled and weekly stained were regarded as non-viable. Pollen germination studies were performed by dusting the freshly dehisced pollen grains in Petri dishes containing the solution of 15 per cent sucrose, 0.5 per cent Agar as solidifying medium and 5ppm Boric acid. After dusting the pollen grains, the Petri dishes were covered. Pollen tube growth was observed under microscope after 24 hours of incubation period at 22±2 ^{0}C. The pollen grains having pollen tube length either equal or exceeding its diameter were considered to be germinated. The pollen tube lengths were observed under ocular microscope. These pollinizers were also observed for the quantity of pollens produced produced per flower. One flower/replication of each pollinizer was collected. Ten anthers of the flower just before dehiscence were transferred on to cavity slide with a drop of water and crushed well with a glass rod to get all the pollen grains out to the water. The contents were then transferred on to a glass vial and the volume was made up to 1 ml using 70% ethyl alcohol. From this, a known amount (1 drop) was transferred with a dropper on to the micro chamber of Improved Neubauer BS 748 I.S.10269 haemocytometer with a depth of 0.1 mm. After placing the cover slip, pollen grains were counted in each of the nine small chambers.

The average pollen grain amount per flower (n) was determined with the flower:

n= Pollen count x 1000 mm^3/0.1 mm/ 1 flower.

3. Results and Discussion

Significant differences were observed among all the pollinizers as far as pollen viability, pollen germination and pollen tube growth are concerned. As evident from Table 1 (Fig 1) the highest pollen viability 99.0 and 98.75 per cent was noticed in *Malus floribunda* and *Golden Hornet* respectively followed by 95.00 per cent in *Manchurian*. The data pertaining to pollen germination reflects distinctive differences in the pollen germination percentage of the pollinizers under study. The maximum pollen germination (63.50%) was recorded in *Malus floribunda* (Fig 2) followed by 58.50% in *Golden Hornet* while as the lowest pollen germination percentage (49.75) was recorded in *Manchurian*. The highest pollen tube length of 1.5 mm was observed in *Malus floribunda* and lowest (1.0 mm) in *Golden Delicious* and *Fenna*. The highest pollen tube length of 1.5 mm was observed in *Malus floribunda* and lowest (1.0 mm) in *Golden Delicious* and *Fenna.*

The variations in pollen viability and germination may be due to genetic differences between the cultivars or these may be because of environmental conditions particularly temperature during the flowering period. These results are in conformity with the findings of Aparecida *et al.* (2004) [2] who reported that temperature is a basic factor in the control of environmental conditions and influences pollen grain germination and longevity. Sharafi and Bahmani (2010) [9] opined that cultivars/genotypes with high pollen germination percentage were not necessarily having high pollen tube length. This phenomenon indicates genetic differences among the genotypes as also reported by many researchers in different fruit tree species and cultivars (Alburquerque *et al*., 2007; Bolat and Pirlak, 1999 and Sharafi, 2011) [1, 3, 8].The highest tube length of 1.5 mm was observed in *Malus floribunda* and lowest (1.0 mm) in *Golden Delicious* and *Fenna*. Pollen tube length at least of diameter of pollen grain or twice the length of pollen grain was considered to be germinated. Pollen being a rich source of auxin and gibberellins which have been isolated from the pollen of a number of temperate fruit plants helps in pollen tube growth (Leopold, 1964) [5]. If we take into account the statements made by Wertheim (1996) [11], who considers the pollen germination as poor when germinability percentage is lower than 25%, it can be seen from the results that all the examined pollinizers had good pollen germination. After counting the pollen grains in haemocytometer, a significant difference were found among the apple pollinizers studied (Table 2) (Fig 3). The pollen production/flower varied from 123750 to 45000. The highest pollen production /flower was observed in *Malus floribunda* (123750) followed by *Golden Delicious* (65000) and the lowest in *Manchurian* (45000). The results are in consonance with that reported by Ozturk (2005) [6] who noticed that the pollen number was from 50249.89 pollen/flower in Red Chief and 71675.44 pollen/flower in Fuji apple.

Table 1: Pollen viability, pollen germination (%) and pollen tube length of different pollinizers.

Pollinizer	Pollen viability (%)	Pollen germination (%)	Pollen tube length (mm)
Golden Delicious	91.5	53.50	1.0
Malus floribunda	99.0	63.00	1.5
Golden Hornet	98.75	58.50	1.3
Manchurian	95.00	49.75	1.2
Fenna	93.50	54.50	1.0
CD (p≤0.05)	0.082	1.83	0.15

Table 2: Pollen production/flower using haemocytometer

Pollinizer	No. of anthers/flower	Pollen count	Pollen/10 anthers	Pollen/ anther	Pollen production/ flower
Golden Delicious	20	3.25	32500	3250	65000
Mauls floribunda	33	3.75	37500	3750	123750
Golden Hornet	20	2.75	27500	2750	55000
Manchurian	20	2.25	22500	2250	45000
Fenna	20	2.50	22500	2500	50000

C.D (p≤0.05) of pollen count = 0.96

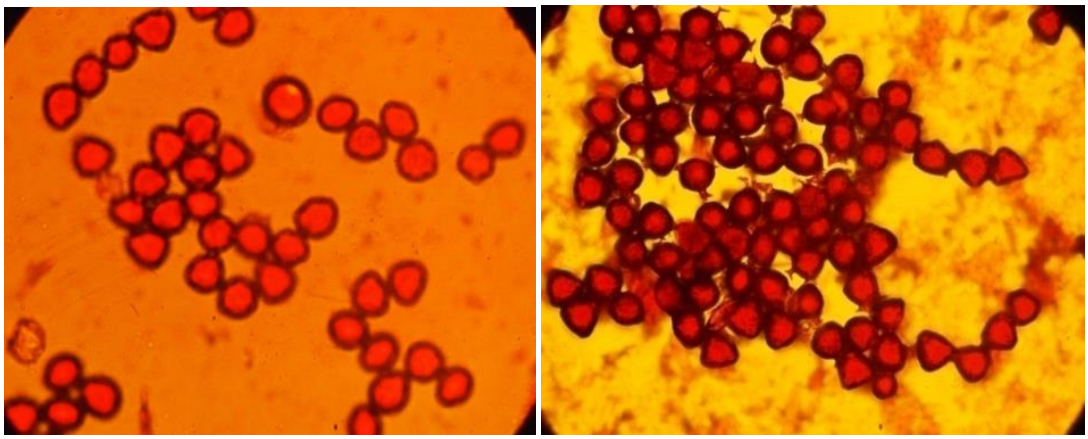

Fig 1: Pollen viability of *Malus floribunda* and *Golden Hornet*

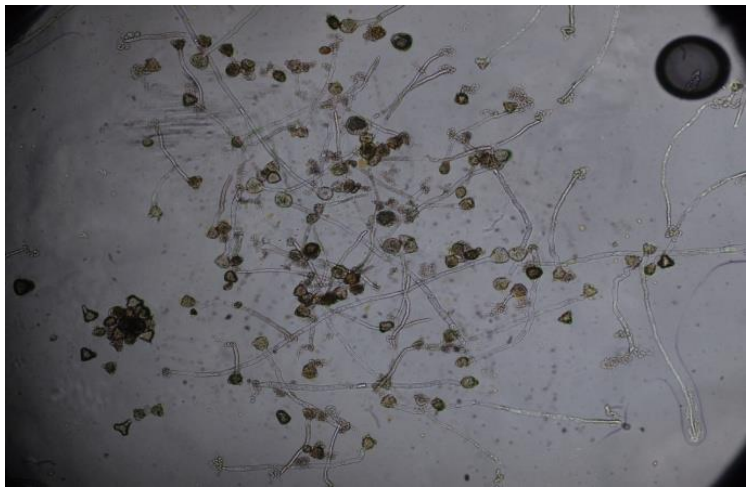

Fig 2: Pollen germination of *Malus floribunda*

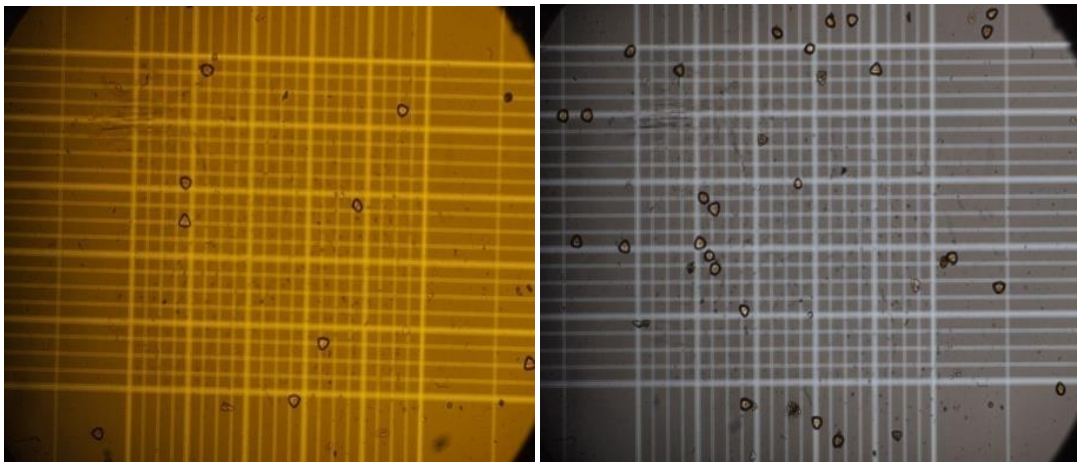

Fig 3: Pollen count in *Malus floribunda.*

4. Conclusion

All the crabs used as pollinizers in present study were found to be the effective pollen sources for pollination of apple, however, the best pollinizer in terms of pollen viability, germination and pollen production was *Malus floribunda* and *Golden Hornet. Malus floribunda* and *Golden Hornet* proved to be the best pollinizers as far as functional ability of pollen is concerned. The overall results indicate that the pollinizers *Malus floribunda, Golden Hornet, Manchurian* and *Fenna* possess promise in terms of various characters studied. It is therefore suggested from this that crabs act as more effective pollinizers since they produce abundant number of viable pollen.

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