Pollination in fruit

Pollination is a basic requirement for production of fruit, seeds and thus new plants. Therefore pollination plays an important role in agriculture, horticulture and forestry. The process of pollination is simply described as the transfer of pollen (male gametes) from stamen (male reproductive organ) to the stigma (part of female reproductive organ) and further to the ovule (female gamete). This transfer process in plants varies. By definition self pollination is the process in which pollen from a plant's stamen (male) is transferred to its stigma (female). Similarly in cross pollination the pollen transfer takes place from a different plant . In cross pollination, the transfer is aided by different catalysts like wind, water, insects, animals and even humans in some cases. Even if some angiosperms(flowering plants) are completely reliant on aboitic forces for transfer of pollen (wind- anemophily, water-hydrophily), more than three quarters of earth's plant population depends on animal pollination (zoophily), bird pollination(ornithophily)and insect pollination (entomophily)for their successful reproduction. (status of pollinators in North America 2007 http://www. nap. edu/openbook. php? record_id= 11761&page= R1). About 500 genera of angiosperms contain species that are ornithophilious , about 250 genera contain chiropterophilious species, and about 875 genera predominantly use abiotic pollination; the remainder contain mostly entomophilous species, with a very small number of oddities using other kinds of animals (Renner and Ricklefs 1995). Pollination is an accidental process. The biotic factors like birds, insects etc. are attracted to the flower for feeding during which their bodies get covered in pollen which is then transferred to the stigma of same flower or stigma of the next flower they visit for feeding. Thus pollination is a mutualistic association between flowering plants and insects and animals.

There has been significant research furthering our understanding and highlighting the importance of pollinators in food production. In the Horticultural Industry, fruit production is a very important sector. Thus understanding the pollination process, pollinators and effects of these pollinators on fruit production is of vital importance. Insect pollinators are in widespread decline and this has important implications for the multiâ€ million pound Horticultural industry in the UK. Two very important fruit crops from a commercial point of view are apples in the top fruits and strawberries in the soft fruit industries. Thus the following is a review of the work done in understanding pollination and the pollinators of these two fruit crops.

Strawberry pollination

Strawberries have hermaphrodite flowers , i. e they have both male and female reproductive organs in each flower. They are also self – pollinating. The stamens are designed in such a way that when they dehisce pollen scattered all around, but it’s not necessary that all the pistils receive the pollen. Thus strawberry is not completely self- fertilizing. Allen and Gaede (1963) analysed fruit-setting of ‘ Shasta’ variety of strawberries in the greenhouse, their findings showed that a few fruits do set in absence of wind and pollinators but wind is important factor and even more important are pollinators. The fertilization of the ovules around the receptacle dictates the weight of the fruit (Nitsch 1952). Fruit quality in terms of individual fruit weight and shape are improved with insect pollination not just amount of fruit harvested (Hughes 1961; Moore 1969; Conner and Martin 1973 , Free 1968).

There has been significant work done in an attempt to understand the pollinators and their activity on strawberry flowers, and consequently the effect on fruit. The study carried out by Albano et al. (2009) allowed us to access the vast spectrum of flower-visiting insects of the strawberry crop and to characterize their visits regarding parameters such as Frequency (F)and Activity rate (AR), used to calculate the Index of visitation rate (IVR). Based on the referred index it was possible to highlight three categories of insect visitors: Syrphidae (Diptera), Apis mellifera L (Hymenoptera) and native bees (Hymenoptera). The studied insects were potentially good pollinators as the pollination rates after one visit was not significantly different. Thus it can be said that it is important to broaden the horizon for pollinator source. This would reduce or eliminate pressure on a single pollinator species.

Roselino et al (2009) examined the success of two stingless bee species in pollinating strawberries in greenhouses. Greenhouse conditions were applied in which control treatment, treatments involving Scaptotrigonaaff depilis and Nannotrigona testaceicornis were investigated. Open field conditions were also applied so as to get different bee visits. The fruit pollinated by Nannotrigona testaceicornis was heavier than that from open field and pollinated by Scaptotrigonaaff depilis. Also the quality of fruit pollinated by the bees was better and was more commercially valuble than that from open field and control conditions. Thus a conclusion was reached that Scaptotrigonaaff depilis and Nannotrigona testaceicornis are competent pollinators of strawberries.

Other examples of pollinators for strawberry are the bumble bees and honey bees. A study was carried out by Li JiLian et al. (2006) it was seen that the behaviour of these two bees was similar but their activity pattern was different due to which bumblebees seem to be more efficient. Behaviour of these bees on the flower in terms of forging is also similar.

Another study by Chagnon, M et al .(1993) compared the efficiency of two different pollinators for strawberries. The relative efficiency was founded by evaluating the relative authority of the number and length of their visits to flowers, their foraging behaviour, and the fertilization rates of the fruit during visits. Finally it was found that for lower visitation rate honey bees were more competent as compared to indigenous bees (Andrenidae, Halictidae, and Megachilidae). honey bees are avrege sized and thus they swivel at top and pollinate top stigmas. the basal stigmas are better pollinated by small. In conclusion it can be said that a complimentary relationship between these two pollinator groups is optimum for strawberry pollination.

From the work done it can be understood that strawberries even though are self fertile plants , including pollinators in the cultivation practice improves the fruit yield in terms of number and quality. There are a number of pollinators which help achieve this improvement but it is still not conclusive which pollinator works to give optimum results.

Apple pollination

Apple is a self infertile plant and thus an obligate cross-pollination process is required for fruit set Griggs (1970). In a commercial orchard there will be pollinator-plants planted which provide the pollen for the rest of the plants.

The transfer of pollen is done by insects Waite (1895, 1899). Anemophily has been suggested and disproved at various times as a possible process for apple pollination (Lewis andVincent 1909, Free 1966). It is no longer considered of significance for this task. Entomophily by wild bees like the genera Andrena, Bombus, Halictus, and Osmia are suggested for apple pollination (Brittain 1933, 1936; Free 1964; Glukhov 1955; Hutson 1926; Kitamura and Maeta 1969; Loken 1958; Phillips 1933; Horticultural Education Association 1967).

In 2000 and 2001, Laduner et al (2004) estimated Osmia cornuta densities required for pollination of ‘ Braeburn’ apple, by caging trees and trees were supplied with different bee densities. One O. cornuta pair per five trees can provide commercially acceptable fruitlet-set, whereas one O. cornuta pair per tree can ensure maximum seed-set and thus high-quality yields on ‘ Braeburn.’ So this Laduner paper shows that the number of pollinators per tree effects fruit set and quality so pollinator abundance in orchards will effect apple quality and abundance.

Further research on O. cornuta was done by Matsumoto et al (2010). They studied the pollinating effectiveness of Osmia cornuta and Apis mellifera on ‘ Comice’ pear . Osmia cornuta visited more flowers per minute (13. 8) than A. mellifera (7. 1-9. 8). Both species visited similar numbers of flowers per tree (6. 7-7. 9), and switched rows with similar frequency (4. 0-7. 9%). Rate of stigma contact was 98. 7% for O. cornuta, 51. 8% for

A. mellifera pollen-nectar foragers, and 19. 0% for A. mellifera nectar foragers. Fruit-set in flowers visited once was 28. 9, 29. 3, and 12. 9%, respectively. Seed set was similar (7-8 seeds per fruit) in all three types of flowers. Osmia cornuta females provisioned their nests with 94. 4% pear pollen. Stepwise multiple regression showed that fruitlet-set across the orchard was mostly related to tree size (trees with fewer flowers set more fruit per flower).

A study was carried out to understand and compare the effectiveness of two pollinators. Pollen removal and deposition activy of Apis and Bombus was studied. It was seen that bumblebees are more efficient in terms of amount of pollen deposited. Bombus had a higher ratio of pollen removed and deposited to that of honey bees. Honey bees deposited less pollen as they apporaced the flower nectaries. Introducing bumblebees to apple orchards in supplementary to honey bees may increase pollen deposition (Thompson et al 2001). Both Matsumoto et al (2010) and Thompson et al (2001)shows that some pollinators are better than others at pollinating top fruit so which pollinators you find in an orchard will effect fruit set and quality.

There has been some research done on knowing and understanding the effects of pollinators on the quality of apples produced. The sugar content, calcium content and mineral content including amount of potassium and magnesium etc was carried out by Volz et al.(1996). They found that partially netting trees reduced, while supplementary pollination increased, initial and final set on spur and terminal sites, seed number and final fruit Ca concentrations. Final set on l-year auxiliary sites was increased by partial netting but reduced by supplementary pollination. Final yield, fruit Mg and K concentrations and average fruit size were unaffected by pollination treatment while hand-thinning level had no effect on fruit distributions, cropping or fruit mineral concentrations. These results show that poor pollination during the early blossom period can reduce fruit Ca concentrations for the ‘ Braebum’ cultivar. This effect may occur by reducing seed numbers in fruit as well as by altering fruit distributions on the tree. Fruit development does not require fertililiation of all the ovules in the ovary , but the more ovules are fertilized the more are the conditions favarble for the fruit to survive and compete for nutrients fruit abortion would be avoided. (Brittain 1933, Tydeman 1943). As well as the number of seeds determine the size of fruit, large fruit has more seeds (Murneek and Schowengert 1935). The optimum seed number is six to seven seeds for good fruit development and set (Hartman and Howlett 1974).

There are a variety of pollinators in the environment. It has been shown that the abundance, diversity and visitation rate of insect pollinators can effect fruit set and quality and that some insect pollinators are better than others at pollinating apples and strawberries. There is a vast scope for research in this field as the effects and consequences of the pollinators and their activity is of great importance to the Horticultural industry.

Considering all these factors and parameters, study to understand the effect of the pollinators on the quality and yield of UK’s two important fruits was carried out. The main aims of the study are ; to compare the effect of different pollinators on the quality of strawberries To determine how pollination by insects effects apple yield and quality. In this study, the parameters which were considered were the commercial quality parameters such as colour, shape etc and the plants were grown in conditions to replicate commercial conditions.