Effect of Heat and Water Stress on Fertility of Reproductive Organs of Three Coconut (*Cocos nucifera* L.) Cultivars Used in Artificial Hybridization and Fate of Fruit Set of Reciprocal Pollination

Amarasinghe K.G.A.P.K.[a], Ranasinghe C.S.[b*], Abeysinghe D.C.[a] and Perera A.A.F.L.K.[c]

[a] Department of Plantation Management, Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka, Makandura, Gonawila (NWP), Sri Lanka;
[b]Plant Physiology Division, Coconut Research Institute, Lunuwilla 61150, Sri Lanka;
[c]Genetics & Plant Breeding Division, Coconut Research Institute, Lunuwilla 61150, Sri Lanka
*Corresponding author (email: sanathanie_ranasinghe@yahoo.com)

Abstract

Production of climate resilient and high yielding Dwarf x Tall hybrids is the main strategy to meet increasing demand of coconut in a changing climate. However, heat- and drought stress (HTDS) induced reproductive failures in Dwarf x Tall hybrid coconut production are already witnessed in the seed gardens of coconut. It is hypothesized that heat and drought stress, especially around meiosis stage (final four months of flower development), -3 (3 months prior to open), -2 (2 months prior to open) -1 (one month prior to open), 0 (month of inflorescence open) stages, could influence flower quality and fruit set of coconut. This study assessed the influence of heat- (Tmax>33°C) and water stress (rainfall<90 mm/month) at the stages around meiosis of micro- and mega-spore mother cells on production (number) and quality (weight and carbohydrates at receptive stage) of Sri Lanka Green Dwarf (SLGD) female flowers, quality of mature pollen (germination (PG%), tube growth (PTL) and carbohydrates) in Sri Lanka Tall (SLT) and San Ramon (SR) varieties and their impact on fruit set of hybrids; SLGD × SLT (CRIC65) and SLGD × SR (*Kapruwana*) under reciprocal pollination strategy.

Male flowers (with mature pollen) and female flowers (at receptive stage) were collected to represent floral development under different water and heat-stressed levels. That included six sampling events with inflorescence exposed to heat and/or water stress at stages around meiosis (flowers opened in March, June and September in two years) and two sampling events that inflorescence developed without stress (controls) around meiosis (flowers opened in December in two years). Reciprocal pollination was achieved by crossing female flowers of emasculated SLGD inflorescence opened in selected eight months and SLT and SR pollen produced in the same months and with pollen produced before three months.

San Ramon showed significantly higher PG% and PTL (43%, 517 µm respectively) compared to that of SLT (37%, 481 µm respectively) variety. Water stress continuously during -3 (pre-meiosis), -2(meiosis) and -1(post-meiosis) stages reduced the PG% and PTL by 64% and 42% respectively, irrespective to the variety. Heat stress at meiosis (-2 stage), combined stress at pre meiosis (-3 stage) significantly reduced starch content in pollen (47% -76% in SR, 49% - 79% in SLT) and SLGD female flowers (90%) irrespective to the HTDS at other development stages compared to non stressed flowers. The total soluble sugar (TSS) content in SR and SLT pollen, accumulated substantially (37% - 43% in SR, 37% - 39% in SLT) when pollen was water stressed at meiosis (-2 stage). Further, water stress prevailed at meiosis stage, reduced female flower production by 33% - 45% compared to non- stressed flowers, irrespective of the heat and/or water stress prevailed in other development stages.

Pollination between no/low stressed parents, resulted higher FS% (68% to 83%) compared to that when both parents were heat and/or water stressed around meiosis stage (35% to 47%). When low/no stressed pollen was used to pollinate stressed SLGD female flowers, the FS% was increased by 21% to 53% compared to HTDS parents. Further, the variations in hybrid fruit set were associated with the quality of both male and female flowers (starch of female flowers at receptive stage (R^2 =0.78), pollen germination (R^2 = 0.52), pollen tube growth (R^2 = 0.59) and total soluble sugars in pollen (R^2 =-0.65)) and female flower number (R^2 = 0.64). The results proved that HTDS around meiosis of male (SR and SLT) and female (SLGD) gametophytes of coconut alter the pollen quality and female flower quality irrespective of the stress prevailed in other development stages which can affect fruit set in dwarf x tall coconut hybrids. Further, fruit set can be increased during stressed months by using non/low stressed pollen to pollinate the stressed female flowers in controlled hybridization of coconut. However good agronomic practices should be carried out to keep the set nuts on bunches until harvesting to get the maximum benefit of increased fruit set.

Keywords: Climate change; Heat and water stress; Coconut hybrids; Flower carbohydrates; Fruit set; Pollen germination

This study was supported by National Research Council of Sri Lanka (NRC 13-032)