Field Dust: How It Affects Pistachio Pollination

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INTRODUCTION

In 2016, we conducted the preliminary research on the effect of dust on pollination and fruit set. Our preliminary study indicated field dust could interfere with pollination and reduce the fruit set and kernel weight per cluster. This year we addressed the following questions:

How does the dust influence the pollination? As a wind-pollinated species, the pollen and stigmas of pistachio (pollen receptor of female floret) are exposed to air and could be contaminated by dust. There are two ways dust can harm pollination and fertilization. First, the dust could decrease both pollen density and activity on the stigma. Second, the dust could directly destroy the stigma or initiate parthenocarpy, which is fruit set without successful fertilization. With parthenocarpy, the dust stimulates the pistil to produce gibberellic acid (GA) for ovary growth resulting in premature nut drop or a blank.

How does dust influence nut growth and split rate? The final economic value in pistachio is a function of the percentage of split nuts. It has been demonstrated that nut split rate is a function of embryo growth. Could the pollen and dust mixture will further influence kernel growth?

Do herbicide residues harm pollination and yield as a direct effect of the herbicide harming the stigma and pollen?

METHOD

Pollen of Peters pistachio was collected in early-blooming orchards. The pollen activity of pollen and dust mixtures at different volume ratios of 1:0, 0:1, 1:1, 1:4, 1:16, 1-1 and 1:1 toxic were tested by AmpaZ30 by Amphasys AG. The 1-1 dust was applied first and pollen 4 hours later. The 1:1 toxic was pollen and dust mixture; with the dust pretreated with GlyStar Plus and Treevix herbicides. Clusters with flowers at the green tip stage were bagged and hand-pollinated with the seven pollen and dust mixtures, at the different ratios, on five successive days. The flower stigma structures were observed by a scanning electron microscope (SEM). Florets of the pollen, dust trials, and the bagged control were sampled and tested for GA concentration by using HPLC-MS. Fruit set, blanking, nut drop, nut split percentage, and nut and embryo size of the cluster unit were recorded.

RESULTS

Herbicide Residues: Compared to the pollen and dust mixtures with volume ratios at 1:0, 0:1, 1:1, 1:4 and 1:16, our results showed that the sample of 1:1 toxic mixture with herbicide pretreated dust destroyed pollen viability (sample size: 4500 particles). This demonstrates that herbicide residues introduced during pollination through dust can destroy pollen viability.

Dust and Yield*:* Dust alone and mixed with pollen, decreased fruit set, pollination and initiated parthenocarpy. Collectively, these results suggested that, at pollination, dust could affect pollination, fruit set, blanks and split percentage and yield.

Stigma: The stigma wilted after the dust application, and the papilla cells of stigmas disappeared with the toxic 1:1 treatment, suggesting again that dust could influence the effective pollination period, and that herbicide residues in the dust were harmful to both pollen and the stigma.

Parthenocarpy: The GA3 content in flowers of both the pollen and dust treatments was higher than in nonpollinated flowers. The increase in GA3 level suggested dust could stimulate parthenocarpy, and therefore oroduce the unexpectedly high percentages of blanks we observed.

CONCLUSION AND APPLICATIONS

Our 2017 results further corroborated preliminary 2016 results—dust during pollination decreased fruit set, increased the blank, and decreased split nuts percentages. Pollen viability and stigma quality are damaged by dust, particularly if contaminated with herbicide residues. Collectively, this data indicates that anything that can be done to decrease dust in the orchard during pollination is recommended; this includes windbreaks if spring winds are a perennial problem, not mowing during pollination, and applying preemergent herbicides as early as possible.

We propose to conduct further trials to study the dust dynamics *in vivo,* in polluted flowers, and explore the mechanism of pistachio parthenocarpy in 2018.

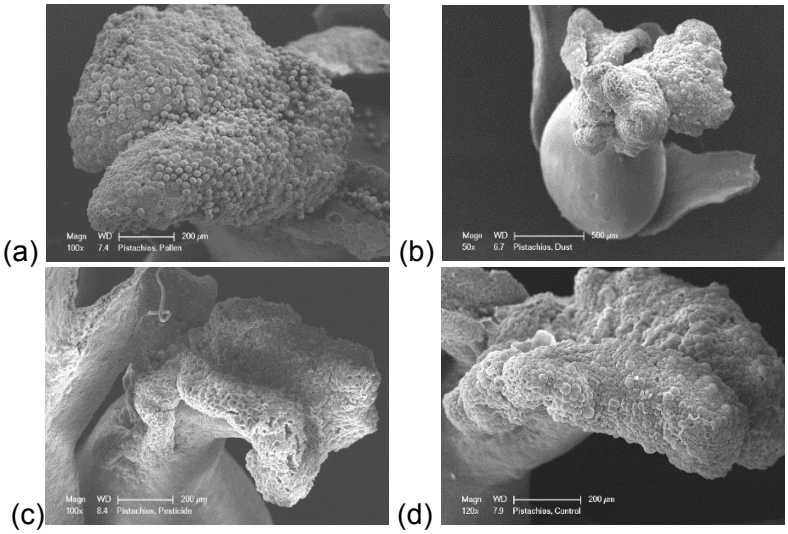

Fig 1. Scanning Electron Microscope (SEM) pictures of stigma structures with (a) pollen applied, (b) dust applied, (c) 1:1 toxic with dust polluted by herbicides applied and (d) control without any application. The female stigma functions as the receptor of pollen and its diameter is

approximately 500 μm. The pollen is spherical and the diameter is 20 μm (a). With the dust treatment (b), the stigma wilted after the application. With the toxic 1:1 treatment (c), the papilla cells of stigmas disintegrated. These results demonstrated that dust can decrease the effective pollination period and that herbicide residues in the dust are harmful to pollen and the stigma.