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Effect of mid season drought on phenolic compounds in peanut genotypes with different levels of resistance to drought

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Drought is a major constraint in peanut production. Drought not only reduces pod yield but also may affect phenolic compounds in peanut. This experiment was conducted for two years under field conditions. Soil moisture levels (field capacity and mid season drought stress) were assigned as main plots, and five peanut genotypes were assigned as sub plots. Peanut seeds were analyzed for phenolic compounds at harvest. Leaves and stems were also analyzed at 30 and 60 days after planting (DAP), and at harvest. Water regimes did not result in significant differences for phenolic compounds in seeds, whereas peanut genotypes were significantly different for this trait. Drought increased phenolic contents in leaves at 60 DAP and phenolic contents were reduced during the recovery period. The production of leaf phenolic compounds differed among genotypes. Mid season drought increased phenolic compounds in stems during the drought period and levels of phenolic production were different depending on peanut genotype. Breeding for high phenolic content and drought tolerance in peanut should be possible because mid season drought did not affect phenolic content in seeds.

1. Introduction

Peanut (*Arachis hypogaea* L.) is not only an excellent source for many nutrients including protein, fatty acids, vitamin E, and magnesium, but also is an important source of phenolic compounds (King et al., 2008). Phenolic compounds are the secondary metabolite in plants that can be strong antioxidant and may have health benefits for humans. Phenolic compounds can limit the incidence of coronary heart diseases and growth of tumor cells and has properties of anti-diabetes, anti-aging and neuro protection (Pandey and Rizvi, 2009).

Peanut is grown in arid and semi-arid areas where droughts can occur at any growth stage. Mid season drought (MD) reduced nodule dry weight, fixed nitrogen and pod yield in peanut genotypes (Dinh et al., 2013). Eicosenoic acid, which is a minor fatty acid in peanut, was also changed under mid season drought stress (Dwivedi et al., 1996). The fatty acid composition, the ratio of oleic to linoleic acid (*O*/*L* ratio), alpha-tocopherol (α-T) and gamma-tocopherol (γ-T) have also been observed to be significantly affected by drought stress (Hashim et al., 1993). Therefore, mid season drought is important for peanut production because it not only reduces pod yield, but also affects seed quality.

Drought induces overproduction of reactive oxygen species (ROS) in plant cells and can cause cell damage and plant death (Sade et al., 2011). Ascorbic acid, glutathione, alkaloids, α-tocopherols and phenolic compounds, non-enzymatic antioxidant defense systems are powerful ROS—scavengers, which protect plant cells from oxidative damage. Many reports found that phenolic compounds were increased under drought stress in different plant parts such as in leaves of *Ctenanthe setosa* (Rosc.) Eichler (Ayaz et al., 1999) and maize (Hura et al., 2008), in roots of *Hypericum brasiliense* Choisy (Abreu and Mazzafera, 2005) and in seed of cumin (Rebey et al., 2012). However, some reports found that phenolic compounds were reduced under water stress such as in tea (Cheruiyot et al., 2007), cherry tomato (Sánchez-Rodríguez et al., 2011), and cotton (Yildiz-Aktas et al., 2009). This indicated that phenolic compounds not only varied among plant parts but also varied among plant species.

The relationship between levels of drought resistance and phenolic compounds has been studied in some crop species. Hura et al. (2008) found that phenolic compounds in leaves were increased only in maize genotypes with drought resistance. Similarly, Hameed et al. (2013) reported that wheat genotypes with drought tolerance showed higher total phenolic content under

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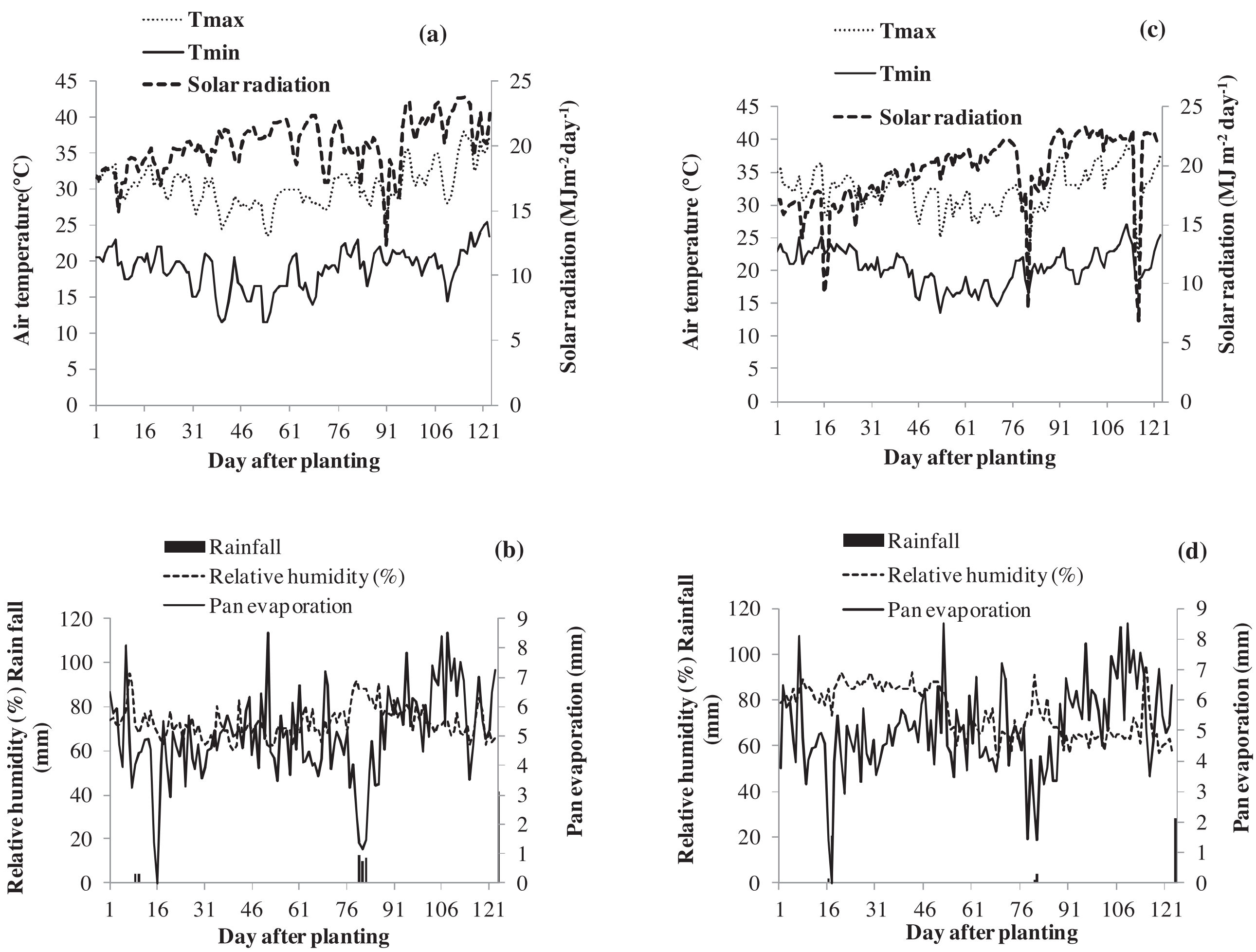

Fig. 1. Maximum (*T*max) and minimum (*T*min) temperature, solar radiation, rainfall, relative humidity (RH) and pan evaporation (Eo) during November–March 2011/12 (year 1; a and b) and 2012/13 (year 2; c and d) at the meteorological station, Khon Kaen University, Thailand.

drought stress compared to sensitive genotypes. Moreover, water stress also resulted in the decreased shikimate pathway and phenolic compounds in the cultivars more sensitive to water stress (Sánchez-Rodríguez et al., 2011).

To our knowledge, information on the effect of drought stress on phenolic compounds in peanut is not available especially in peanut genotypes with different levels of resistance to drought. Different plant parts of peanut might also produce different amounts of phenolic compounds and peanut genotypes might respond differently to drought stress for phenolic compounds in different plant parts. Therefore, the objective of this study was to investigate the effect of mid season drought on phenolic content in leaves, stems and seeds of peanut genotypes with different levels of resistance to drought. The results might help breeders to select peanut lines with high seed quality and resistance to mid season drought.

2. Experimental

2.1. Location and experimental design

The experiment was conducted under field conditions at the field crop research station, Khon Kaen University, Thailand (16°28′N, 102°48′E, 200 m above mean sea level) during the dry season from November 2011 to March 2012 and repeated during the dry season from November 2012 to March 2013. A split-plot design with four replications was used for this study. Main plots were two water levels, FC (field capacity) and MD (mid season drought—no irrigation during 30–60 days after planting, DAP), and sub-plots were five peanut genotypes (Tifton 8, ICGV 98305, KKU 60, KS 2 and Tainan 9).

The five peanut genotypes were selected based on differences in rooting patterns and pod yield under mid season drought (Jongrungklang et al., 2012). Tifton 8 is a drought tolerant variety with high yield and a large root system received from the United State Department of Agriculture (USDA). ICGV 98305 is a drought tolerant variety from the International Crops Research Institute for the Semi-Arid Tropics and has high pod yield under pre-flowering drought stress. KKU 60 is a recently released cultivar in Thailand and Jongrungklang et al. (2012) reported that this cultivar has tolerant to drought and high yield and high root length density in the lower soil layer. KS 2 and Tainan 9 are drought sensitive genotypes, which are widely planted in Thailand. They had low pod yield under mid season drought and had high root length density in the upper soil layer (Jongrungklang et al., 2012).

2.2. Crop management

The soil was plowed three times and plot size was 5.5 × 5 m with a spacing of 50 cm between rows and 20 cm between plants within the row. Seeds were treated with captan (3a,4,7,7a-tetrahydro-2-[(trichloromethyl) thio]-1Hisoindole-1, 3 (2H)-dione) at the rate of 5 g kg^{-1} seeds to control *Aspergillus niger*. The seeds of KKU 60 and Tifton 8 were treated with ethryl (2-chloroethylphosphonic acid) 48% at the rate of 2 ml L^{-1} water to break seed dormancy.

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