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EFFECT OF WATER LOGGING ON PHOTOSYNTHESIS, FV/FM, STOMATAL CONDUCTANCE, TRANSPIRATION, WATER USE EFFICIENCY AND YIELD OF SESAME GENOTYPES

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EFFECT OF WATER LOGGING ON PHOTOSYNTHESIS, FV/FM, STOMATAL CONDUCTANCE, TRANSPIRATION, WATER USE EFFICIENCY AND YIELD OF SESAME GENOTYPES

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ABSTRACT

Islam MT, Khatoon M (2022) Effect of water logging on photosynthesis, Fv/Fm, stomatal conductance, transpiration, water use efficiency and yield of sesame genotypes. *Int. J. Expt. Agric*. 12(1), 14-16.

Water logging is an environmental factor that reduces gas exchange between plant tissues and the atmosphere and limits plant growth and yield. A pot experiment was conducted with eight sesame genotypes *viz*. SM1, SM4, SM7, SM9, SM25, SM26, Kristotil and Binatil-2 during March to June 2021 to observe the effect of water logging on photosynthesis and its related parameters and yield of sesame genotypes. The experiment was laid out in randomized complete block design with three replications. Three waterlogged treatments *viz*. Control, 48 and 60 hours were imposed at flowering stage of the sesame genotypes. Photosynthesis, Fv/Fm, stomatal conductance, transpiration, water use efficiency andseed yield plant^{-1} were significantly decreased with increasing water logging periods. However, the genotypes responded differently on those plant parameters. SM26, SM25, SM4 and Kristotil showed better performance under water logging.

Key words: *photosynthesis, Fv/Fm, stomatal conductance, transpiration, water use efficiency, sesame yield*

INTRODUCTION

Water logging reduces gas exchange between plant tissues and the atmosphere resulting in an imbalance between slow diffusion and rapid consumption of oxygen in the rhizosphere that drastically reduces the oxygen supply and induces anoxia in plants (Sachs *et al*. 1980). Short-term water logging often firstly causes oxygen deficiency (hypoxia or anoxia) in plants and leads to root damage (Grassini *et al*. 2007). Water logging causes a shortfall in oxygen availability to plants which is felt directly by the root system, and indirectly by the shoots (Capon *et al*. 2009). In tissue suffering hypoxia (and specially anoxia), oxygen-depending processes are suppressed, both carbon assimilation and photosynthate utilization are inhibited, and functional relationships (especially the internal transport of oxygen) between roots and shoots are disrupted (Chugh *et al*. 2012). The response of a plant to hypoxia can be conceptually divided into three stages. Initially, the plant rapidly induces a set of signal transduction components, which then activates the second stage, a metabolic adaptation involving fermentation pathways. Finally, the third stage involves morphological changes such as the formation of gas filled air spaces (aerenchima) and/or adventitious root depending on the tolerance of the plant (Jackson and Colmer, 2005; Evans 2003; Justin and Armstrong, 1987). Sesame (*Sesamum indicum*), a crop with high oil content, has the potential capacity to combat nutritional deficiencies in developing regions and countries. Most current cultivars contain 50-60% oil and 18-24% protein in their seeds (Mondal *et al*. 2010). In particular, greater than 80% of its oil is in the form of unsaturated fatty acids, which are more beneficial for human health than are saturated fatty acids. In addition, the antioxidant properties of sesamelignans, primarily sesamin and sesamolin, are used for the rapeutic and cosmetic applications (Nakano *et al*. 2006). Sesameis typically considered drought-tolerant but susceptible to waterlogging a property that can be ascribed to its suspected origin in Africa or India and its subsequent dispersal to tropical or semi tropical regions (Ram *et al*. 1990 and Bedigian 2004). To understand the effects of abiotic stress in an effort to maintaina stable food supply, anumber of studies have investigated the responses of model plants and crops to stresses (Rasmussen *et al*. 2013). These studies have revealed that plant responses to different stresses are coordinated by complex and often interconnected signaling pathways that regulate numerous metabolic networks (Miro and Ismail, 20l3). At the protein level, low oxygen selectively induces the synthesis of anaerobic proteins, especially enzymes involved in sugar metabolism, glycolysis and fermentation (Komatsu *et al*. 2009). Vast majority of these proteins have been investigated in water logging-susceptible or tolerant strains of Arabidopsis or rice (Nakashima *et al*. 2009; Atkinson *et al*. 2013). A few sesame genotypes with some toleranceto waterlogging were reported by Islam *et al*. 2006; Islam and Khatoon, 2018. In this study, photosynthesis and its related parameters and yield of eight sesame genotypes were investigated under water logging.

MATERIALS AND METHODS

A pot experiment was conducted with eight sesame genotypes *viz*. SM1, SM4, SM7, SM9, SM25, SM26, Kristotil and Binatil-2 at BINA pot yard, Myrnensingh during March to June 2021. Each pot contained 8 kg soil collected from BINA farm. Urea, TSP, MP and Zypsum were applied 125, 150, 50 and 10 kg ha^{-1}, respectively. Half of urea and all other fertilizers were mixed with pot soils and remain in urea was applied at 30 days after sowing. Seeds were sown on 3 March 2019. After seedling establishment one seedling was allowed to grow in each pot. The experiment was laid out in randomized complete block design with three replications. Four water logging treatments: control and waterlogged periods of 48 and 60 hours were imposed at flowering stage of the sesame genotypes. Data on photosynthesis, Fv/Fm, stomatal conductance, transpiration, water use efficiency were collected during stress imposition and seed yield plant^{-1} was collected at maturity. Data were analyzed statistically and DMRT was done to compare the means.

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RESULTS AND DISCUSSION

Results revealed that photosynthesis, Fv/Fm, stomatal conductance, transpiration, water use efficiency and seed yield plant^{-1} significantly decreased with increasing water logging periods (Table1). The results agree with Wei *et al.* 2013; Islam *et al.* 2017; Islam and Khatoon, 2020a; Islam and Khatoon, 2020b). The highest photosynthesis was observed in SM25 and SM26 followed by SM4 and Kristotil (Table 2). SM25, SM26, SM9, SM7 and Binatil-2 had higher photosynthetic efficiency. Better water use efficiency was observed in SM25 and SM26 followed by SM4 and Kristotil. SM4 produced the highest seed yield followed by SM26 and Kristotil. The highest seed yield was produced by SM26 in control and the lowest by SM1 at 60-hr water logging (Table 3). The above results showed that SM26, SM25, SM4 and Kristotil performed better under water logging.

Table 1. Effect of water logging on photosynthesis, Fv/Fm, stomatal conductance, transpiration, water use efficiency of sesame genotypes

Treatment	**Photosynthesis (µmolCO$_2$m^{-2}s^{-1})**	**Fv/Fm**	**Stomatal conductance (mmolH$_2$Om^{-2}s^{-1})**	**Transpiration (mmolH$_2$Om^{-2}s^{-1})**	**Water use efficiency**	**Seed yield plant^{-1}(g)**
Control	26.42a	0.84a	0.26a	3.69a	7.17a	5.96a
48-hr water logging	23.04b	0.82b	0.25b	3.56b	6.47b	3.41b
60-hr water logging	19.63c	0.79c	0.22c	3.27c	6.00c	1.70c

Values having common letter(s) in a column do not differ significantly at 5% level as per DMRT

Table 2.Varietal performance on photosynthesis, Fv/Fm, stomatal conductance, transpiration and water use efficiency of sesame genotypes under water logging

Variety	**Photosynthesis (µmolCO$_2$m^{-2}s^{-1})**	**Fv/Fm**	**Stomatal conductance (mmolH$_2$Om^{-2}s^{-1})**	**Transpiration (mmolH$_2$Om^{-2}s^{-1})**	**Water use efficiency**	**Seed yield plant^{-1}(g)**
SM1	22.00c	0.80c	0.24c	3.52abc	6.22c	3.79c
SM4	23.67b	0.81c	0.24c	3.44c	6.86ab	4.55a
SM7	22.11c	0.81bc	0.24c	3.53ab	6.23c	2.82g
SM9	21.67c	0.82b	0.24c	3.53ab	6.10c	3.28f
SM25	25.00a	0.83a	0.25a	3.56a	7.02a	3.62d
SM26	24.56a	0.83a	0.25ab	3.48abc	7.06a	3.96b
Kristotil	23.67b	0.80c	0.24bc	3.53ab	6.68b	3.97b
Binatil-2	21.56c	0.81bc	0.24c	3.46bc	6.20c	3.52e

Values having common letter(s) in a column do not differ significantly at 5% level as per DMRT

Table 3. Combined effect of water logging and sesame genotypeson photosynthesis, Fv/Fm, stomatal conductance, transpiration and water use efficiency

Variety x Treatment	**Photosynthesis (µmolCO$_2$m^{-2}s^{-1})**	**Fv/Fm**	**Stomatal conductance (mmolH$_2$Om^{-2}s^{-1})**	**Transpiration (mmolH$_2$Om^{-2}s^{-1})**	**Water use efficiency**	**Seed yield plant^{-1}(g)**
V_1 x T_1	25.67bc	0.83abcd	0.26bc	3.67ab	7.00abcd	6.01d
V_1 x T_2	22.33ef	0.82cde	0.24d	3.60bc	6.21fgh	4.32fg
V_1 x T_3	18.00i	0.76j	0.22fg	3.30d	5.45ij	1.04o
V_2 x T_1	26.67ab	0.83abcd	0.26bc	3.63abc	7.35a	6.19c
V_2 x T_2	23.67de	0.82bcde	0.24d	3.50c	6.76bcde	4.24g
V_2 x T_3	20.67gh	0.77ij	0.22fg	3.20d	6.46efg	3.21ij
V_3 x T_1	26.00abc	0.83abc	0.26bc	3.70ab	7.03abcd	4.41f
V_3 x T_2	22.33ef	0.82bcde	0.24d	3.60bc	6.21fgh	2.78k
V_3 x T_3	18.00i	0.77ij	0.22fg	3.30d	5.46ij	1.28n
V_4 x T_1	26.00abc	0.84a	0.26bc	3.70ab	7.03abcd	5.43e
V_4 x T_2	21.67fgh	0.82cde	0.24d	3.60bc	6.02gh	3.21ij
V_4 x T_3	17.33i	0.79gh	0.22fg	3.30d	5.26j	1.21n
V_5 x T_1	27.33a	0.84a	0.26ab	3.77a	7.26a	6.12cd
V_5 x T_2	25.67bc	0.83abcd	0.25c	3.60bc	7.13abc	3.06j
V_5 x T_3	22.00fg	0.81ef	0.23e	3.30d	6.67cdef	1.69m
V_6 x T_1	26.33ab	0.84a	0.27a	3.67ab	7.18ab	6.80a
V_6 x T_2	24.67cd	0.83abcd	0.25c	3.50c	7.05abcd	3.56h
V_6 x T_3	22.67ef	0.82def	0.22ef	3.27d	6.94abcde	1.53m
V_7 x T_1	26.67ab	0.83abcd	0.26abc	3.70ab	7.21ab	6.19c
V_7 x T_2	23.67de	0.80fg	0.24d	3.60bc	6.58def	3.37i
V_7 x T_3	20.67gh	0.78hi	0.22ef	3.30d	6.26fgh	2.36l
V_8 x T_1	26.67ab	0.84ab	0.26bc	3.67ab	7.28a	6.57b
V_8 x T_2	20.33h	0.81ef	0.24d	3.50c	5.81hi	2.75k
V_8 x T_3	17.67i	0.78i	0.21g	3.20d	5.52ij	1.25n

Values having common letter(s) in a column do not differ significantly at 5% level as per DMRT

Where, V_1= SM1, V_2= SM4, V_3= SM7, V_4= SM9, V_5= SM25, V_6= SM26, V_7= Kristotil and V_8= Binatil-2, T_1= Control, T_2= 48-hr water logging and T_3= 60-hr water logging

CONCLUSION

Photosynthesis, Fv/Fm, stomatal conductance, transpiration, water use efficiency and seed yield plant^{-1} of sesame genotypes significantly decreased with increasing water logging periods. However, the genotypes responded differently on those plant parameters. SM26, SM25, SM4 and Kristotil showed better performance under water logging.

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