Reprint ISSN 1923-7766 (Web Version)

International Journal of Experimental Agriculture

(Int. J. Expt. Agric.)

Volume: 8	Issue: 1	March 2018

Int. J. Expt. Agric. 8(1): 10-14 (March 2018)

MORPHO-PHYSIOLOGICAL PARAMETERS AND YIELD OF SOME SESAME LAND RACES UNDER DIFFERENT WATER LOGGING PERIOD

M.T. ISLAM AND M. KHATOON

An International Scientific Research Publisher

Green Global Foundation©

Web address: http://ggfjournals.com/e-journals archive
E-mails: editor@ggfjournals.com and editor.int.correspondence@ggfjournals.com

ISSN-1923-7766 (Online)
Int. J. Expt. Agric. 8(1):10-14(March 2018)

MORPHO-PHYSIOLOGICAL PARAMETERS AND YIELD OF SOME SESAME LAND RACES UNDER DIFFERENT WATER LOGGING PERIOD

M.T. ISLAM* AND M. KHATOON

Crop Physiology Division, Bangladesh Institute of Nuclear Agriculture, Mymensingh-2202, Bangladesh.

*Corresponding author & address: Dr. Md. Tariqul Islam, E-mail: islamtariqul05@yahoo.com
Accepted for publication on 25 February 2018

ABSTRACT

Islam MT, Khatoon M (2018) Morpho-physiological parameters and yield of some sesame land races under different water logging period. *Int. J. Expt. Agric.* 8(1), 10-14.

A pot experiment was conducted with seven sesame genotypes *viz*., Rajshahi Khoyeri, Kistotil Chapai, Kathtil Chapai, Gopalgonj MV-40, Gopalgong Black, Kalotil Gopalgong and Laltil Gopalgonj at BINA farm, Mymensingh during March to June 2017. Four water logging treatments *viz*., Control, 24, 48 and 72 hours were imposed at flowering stage of the sesame genotypes. Plant height, number of branches, capsules and seeds plant^{-1}, number of seeds capsule^{-1}, total dry matter plant^{-1}, 1000-seed weight, seed yield plant^{-1}, photosynthesis, nitrate reeducate activity were significantly decreased with increasing water logging periods. Four sesame genotypes *viz*., Rajshahi khoyeri, Kistotil Chapai, Kathtil Chapai and Laltil Gopalgonj showed higher yield than others under the treatments.

***Key words**: sesame, water logging, morpho-physiological parameters, yield*

INTRODUCTION

Water logging is an environmental factor that limits plant growth and yield. 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 (Kozlowski 1984 and Sachs *et al*. 1980).

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 and Ram *et al*. 1990). 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 sesame lignans, primarily sesamin and sesamolin, are used for therapeutic and cosmetic applications (Nakano *et al*. 2006 and Miyahara *et al*. 2000). Sesame is typically considered drought-tolerant but susceptible to water logging, a property that can be ascribed to its suspected origin in Africa or India and its subsequent dispersal to tropical or semitropical regions (Ram *et al*. 1990 and Bedigian 2004). According to the Food and Agricultural Organization, the average sesame yield was alarmingly low at only 617 kg/ha worldwide in 2011 and ranked second to last among 22 oil crops between 2007 and 2011. This low yield may be attributed to several reasons, but water logging is a primary factor.

To understand the effects of abiotic stress in an effort to maintain a stable food supply, a number of studies have investigated the responses of model plants and crops to stresses (Rasmussen *et al*. 2013 and Nakashima *et al*. 2009). These studies have revealed that plant responses to different stresses are coordinated by complex and often interconnected signaling pathways that regulate numerous metabolic networks (Nakashima *et al*. 2009 and Miro and Ismail, 2013). At the protein level, low oxygen selectively induces the synthesis of anaerobic proteins, especially enzymes involved in sugar metabolism, glycolysis and fermentation (Huang *et al.* 2005; and Komatsu *et al*. 2009). The vast majority of these proteins have been investigated in water logging-susceptible or tolerant strains of *Arabidopsis* or rice (Nakashima *et al*. 2009; Bahmanyar 2007 and Atkinson *et al*. 2013). Despite an increased understanding of the adaptive mechanisms and molecular regulation at play in other crops, the mechanisms underlying the sesame response to water logging need further elucidation (Wei *et al*. 2013 and Wang *et al*. 2012).

MATERIALS AND METHODS

A pot experiment was conducted with seven sesame genotypes *viz*., Rajshahi Khoyeri, Kistotil Chapai, Kathtil Chapai, Gopalgonj MV-40, Gopalgong Black, Kalotil Gopalgong and Laltil Gopalgonj at BINA farm, Mymensingh during March to June 2017. The sesame land races were collected from different agro-ecological zones of Bangladesh. The objective of the study was to find out the water logging tolerant genotypes. Four water logging treatments *viz.* control and water logging periods of 24, 48 and 72 hours were imposed at flowering stage of the sesame genotypes. Each pot contained 8 kg soil collected from BINA farm. Urea, TSP, MP and Gypsum were applied 125, 150, 50 and 110 kg ha^{-1}, respectively. Half of urea and all other fertilizers were mixed with pot soils and remaining urea was applied at 30 days after sowing. After seedling establishment one seedling was allowed to grow in each pot. The experiment was laid out in completely randomized design with three replications. Data on plant height, number of branches, capsules and seeds plant^{-1}, number of seeds capsule^{-1}, shoot dry weight, root dry weight and total dry matter plant^{-1}, 1000-seed weight, seed yield plant^{-1}, SPAD reading, photosynthesis and nitrate reeducate activity were recorded. Data were analyzed statistically and DMRT was used to compare the means.

RESULTS AND DISCUSSION

Results revealed that plant height, number of branches, capsules and seeds plant^{-1}, number of seeds capsule^{-1}, total dry matter plant^{-1}, 1000-seed weight, seed yield plant^{-1}, photosynthesis, nitrate reeducate activity and chlorophyll content was significantly decreased with increasing water logging periods (Table 1 and Table 4). Similar results were observed by many researchers (Sarker *et al*. 2016; Wei *et al*. 2013; Wang *et al.* 2011, 2000; and Islam *et al*. 2006. Four genotypes *viz*. Rajshahi Khoyeri, Kistotil Chapai, Kathtil Chapai and Laltil Gopalgonj showed higher yield (Table 2). The highest total dry matter was observed in the treatment combination of T_1 x V_2 followed by T_1 x V_1 with same statistical rank (Table 3). The higher yield under water logging condition was found in Rajshahi Khoyeri, Kistotil Chapai, Kathtil Chapai and Laltil Gopalgonj (Table 2). Therefore, these four genotypes showed more tolerance to water logging at flowering stage.

Table 1. Effect of water logging period on morphological, physiological, seed yield and yield components of sesame genotypes

Water logging period	Morphological parameters		Physiological parameters			Yield attributes and seed yield				
	Plant height (cm)	Branches plant^{-1} (no.)	Shoot dry weight plant^{-1} (g)	Root dry weight plant^{-1} (g)	Total dry matter plant^{-1} (g)	Capsules plant^{-1} (no.)	Seeds capsule^{-1} (no.)	Seeds plant^{-1} (no.)	1000-seed weight (g)	Seed weight plant^{-1} (g)
Control	63.1a	4.95a	5.85a	1.33a	7.05a	37.67a	63.67a	2385a	2.74a	6.54a
24 hrs	49.0b	1.66b	4.14b	1.01b	5.04b	28.01b	47.81b	1313b	2.44b	3.19b
48 hrs	44.7c	1.15c	2.87c	0.94bc	3.81c	21.29c	33.62c	703.7c	2.82c	1.59c
72 hrs	40.1d	0.96c	1.51d	0.76c	2.24d	10.52d	24.19d	255.2d	1.77d	0.44d

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

Table 2. Effect of water logging condition on plant height, biomass production, yield and yield components of sesame genotypes

Genotypes	Plant height (cm)	Shoot dry weight plant^{-1} (g)	Root dry weight plant^{-1} (g)	Total dry matter plant^{-1} (g)	Capsules plant^{-1} (no.)	Seeds capsule^{-1} (no.)	Seeds plant^{-1} (no.)	1000-seed weight (g)	Seed weight plant^{-1} (g)
Rajshahi Khoyeri	45.67cd	4.08a	0.92	4.93a	20.33d	51.8a	1233ab	2.44a	3.83a
Kistotil Chapai	41.67d	4.01a	0.96	4.97a	21.67cd	46.9ab	1209ab	2.27bc	2.94ab
Kathtil Chapai	48.00bc	3.23b	1.13	4.35ab	29.83a	45.7bc	1311a	2.42ab	3.42a
Gopalgonj MV-40	52.92a	3.24b	0.87	4.08b	28.25a	35.8c	1153ab	2.13c	2.76b
Gopalgong Black	52.67ab	3.36b	1.12	4.22b	24.08bc	37.2bc	1040b	2.45a	2.71b
Kalotil Gopalgong	51.67ab	3.37b	1.07	4.25b	21.33d	40.9bc	1037b	2.16c	2.45b
Laltil Gopalgonj	52.08ab	3.89a	0.97	4.86a	25.08b	38.0bc	1166ab	2.24bc	2.89ab

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

Table 3. Interaction effect of water logging condition on plant height, biomass production, yield and yield components of sesame genotypes

Interaction	Plant height (cm)	Shoot dry weight plant^{-1} (g)	Root dry weight plant^{-1} (g)	Total dry matter plant^{-1} (g)	Capsules plant^{-1} (no.)	Seeds capsule^{-1} (no.)	Seeds plant^{-1} (no.)	1000-seed weight (g)	Seed weight plant^{-1} (g)
V_1T_1	58.3bcd	6.67ab	1.12b-e	7.80a	38.0a-d	74.3a	2823a	3.00ab	8.42a
V_1T_2	45.0g-j	4.20efg	0.66cde	4.86cde	21.0hi	58.7a-d	1226ef	2.50cde	3.05d
V_1T_3	45.0g-j	3.14h-k	0.95b-e	4.10e-h	15.3ij	43.3b-j	668.7gh	2.56cd	1.68efg
V_1T_4	34.3kl	2.17j-m	0.94b-e	3.04hij	7.0k	30.7g-m	215.3i	1.70lm	0.36hij
V_2T_1	56.7cde	6.83a	1.05b-e	7.88a	36.0b-e	74.3a	2669ab	2.43c-g	6.40b
V_2T_2	41.3ijk	4.87c-f	0.91b-e	5.78bcd	23.7gh	56.6a-f	1342ef	2.63bcd	3.55d
V_2T_3	39.7ijk	2.88ijk	1.02b-e	3.90e-h	18.0hi	34.7f-m	628gh	2.43c-g	1.53f-i
V_2T_4	29.0l	1.46 lm	0.86b-e	2.32ijk	9.0k	22.0j-m	197.3i	1.6m	0.32ij
V_3T_1	67.0ab	5.63cd	1.40ab	7.03ab	42.6a	51.6b-g	2203cd	3.07a	6.79b
V_3T_2	43.3g-k	3.47ghi	1.02b-e	4.77c-f	32.7def	41.0b-k	1342ef	2.53cde	3.37d
V_3T_3	38.7jk	2.31jkl	1.27abc	3.48f-i	28.3fg	35.7e-l	1001fg	2.36c-i	2.35def
V_3T_4	43.0h-k	1.26m	0.85b-e	2.12jk	15.7ij	54.3a-f	697gh	1.73klm	1.16f-j

Cont'd

Interaction	Plant height (cm)	Shoot dry weight plant^{-1} (g)	Root dry weight plant^{-1} (g)	Total dry matter plant^{-1} (g)	Capsules plant^{-1} (no.)	Seeds capsule^{-1} (no.)	Seeds plant^{-1} (no.)	1000-seed weight (g)	Seed weight plant^{-1} (g)
V_4T_1	67.0ab	5.50cd	1.2bcd	6.7ab	41.3ab	58.0a-e	2399bc	2.74abc	6.57b
V_4T_2	50.00d-i	3.69ghi	1.0bcde	4.54d-g	32.3def	39.6c-k	1288ef	2.13e-k	2.74de
V_4T_3	52.0c-h	2.55jk	0.65cde	3.2g-j	23.7gh	26.7i-m	628.7gh	2.00h-m	1.25f-j
V_4T_4	42.7h-k	1.25m	0.63de	1.89jk	15.6ij	18.6klm	295.3hi	1.67lm	0.47g-j
V_5T_1	56.0c-f	5.04cde	1.84a	5.91bc	35.0cde	62.0abc	2161cd	2.70abc	5.85bc
V_5T_2	60.3abc	3.97fgh	0.96b-e	4.94cde	27.3fg	42.3b-j	1163ef	2.63bcd	3.07d
V_5T_3	47.3e-j	3.08hij	0.82b-e	3.90e-h	23.7gh	28.0h-m	668gh	2.50cde	1.62e-h
V_5T_4	47.0e-j	1.33 lm	0.82b-e	2.12jk	10.3jk	16.6lm	168i	1.96i-m	0.33ij
V_6T_1	68.00a	5.40cd	1.36ab	6.77ab	31.6ef	62.3abc	197d	2.47c-f	4.96c
V_6T_2	53.6c-g	3.89f-i	1.36ab	4.63c-f	27.0fg	50.6b-h	1373ef	2.4c-h	3.28d
V_6T_3	44.3g-k	3.00hij	0.92b-e	3.93e-h	19.3hi	36.0d-l	691.3gh	2.04g-l	1.39f-j
V_6T_4	40.0ijk	1.17m	0.66cde	1.68k	7.33k	14.7lm	108.7i	1.76klm	0.19j
V_7T_1	68.0ab	5.86bc	1.35ab	7.21a	39.0abc	63.0ab	2464abc	2.76abc	6.81b
V_7T_2	49.3d-i	4.64d-g	1.11b-e	5.75bcd	32.0ef	45.6b-i	1454e	2.23d-j	3.25d
V_7T_3	46.0f-j	3.16hij	0.91b-e	4.07e-h	20.7hi	31.0g-m	640gh	2.06f-l	1.31f-j
V_7T_4	45.0g-j	1.90klm	0.52e	2.43ijk	8.67k	12.3m	104.7i	1.9j-m	0.19j

Values having common letter(s) in a column do not differ significantly at 5% level as per DMRT; Where, T_1= Control, T_2= 24 hours water logging, T_3= 48 hours water logging, T_4= 72 hours water logging, V_1= Rajshahi Khoyeri, V_2= Kistotil Chapai, V_3= Kathtil Chapai, V_4= Gopalgonj MV-40, V_5= Gopalgong Black, V_6= Kalotil Gopalgong and V_7= Laltil Gopalgonj

Table 4. Effects of water logging period on physiological and biochemical parameters of sesame genotypes

Water logging time	SPAD Reading (Chlorophyll)	Photosynthetic rate (µmolCO$_2$ m^{-2}S^{-1})	NR Activity (µ moN0$_2$/gfw/h)
Control	35.57a	41.12a	0.414a
24 hrs	25.68c	35.58b	0.349b
48 hrs	28.43b	33.82c	0.281c
72 hrs	20.93d	32.89c	0.245d

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

Table 5. Variation in physiological and biochemical parameters of sesame genotypes under different water logging period

Genotypes	SPAD Reading (Chlorophyll)	Photosynthetic rate (µmolCO$_2$ m^{-2}S^{-1})	NR Activity (µ moN0$_2$/gfw/h)
Rajshahi Khoyeri	28.54ab	35.81	0.34b
Kistotil Chapai	26.49cd	35.24	0.46a
Kathtil Chapai	29.64a	35.54	0.32bc
Gopalgonj MV-40	29.03a	36.11	0.27d
Gopalgong Black	27.42bc	36.08	0.30cd
Kalotil Gopalgong	26.65cd	36.45	0.23e
Laltil Gopalgonj	25.78d	35.74	0.30cd

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

Table 6. Interaction effects of water logging condition on physiological and biochemical parameters of sesame genotypes

Interaction	SPAD Reading (Chlorophyll)	Photosynthetic rate (µmolCO$_2$ m^{-2}S^{-1})	NR Activity (µ moN0$_2$/gfw/h)
V_1T_1	34.33bcd	41.53a	0.44c
V_1T_2	22.2no	35.83bc	0.37d
V_1T_3	29.53e-h	33.53bcd	0.29fgh
V_1T_4	28.1ghi	32.33cd	0.28f-i
V_2T_1	38.5a	41.4a	0.64a
V_2T_2	22.5mno	35.57bc	0.53b
V_2T_3	28.87f-i	32.5cd	0.38cd
V_2T_4	16.1p	31.5d	0.31e-h

Cont'd

Interaction	SPAD Reading (Chlorophyll)	Photosynthetic rate ($\mu molCO_2\ m^{-2}S^{-1}$)	NR Activity ($\mu\ moN0_2$/gfw/h)
V_3T_1	34.77bc	41.07a	0.41cd
V_3T_2	25.37jkl	35.23bcd	0.35de
V_3T_3	31.03ef	34.03bcd	0.29f-h
V_3T_4	27.4hij	31.83cd	0.27f-j
V_4T_1	38.77a	42.73a	0.32e-g
V_4T_2	24.43k-n	35.73bcd	0.29f-g
V_4T_3	30.03e-h	33.67bcd	0.26g-k
V_4T_4	22.9l-o	32.3cd	0.25h-l
V_5T_1	33.77cd	40.6a	0.41cd
V_5T_2	29.7e-h	34.57bcd	0.32e-g
V_5T_3	24.97j-m	33.87bcd	0.27f-j
V_5T_4	21.27o	35.27bcd	0.21kl
V_6T_1	32.13de	40.43a	0.29f-h
V_6T_2	28.97e-h	35.4bcd	0.26f-k
V_6T_3	30.37efg	34.47bcd	0.21j-l
V_6T_4	15.13p	35.5bcd	0.19l
V_7T_1	36.7ab	40.1a	0.41cd
V_7T_2	26.57ijk	36.7b	0.32ef
V_7T_3	24.23k-n	34.7bcd	0.28f-i
V_7T_4	15.63p	31.47d	0.21i-l

Values having common letter(s) in a column do not differ significantly at 5% level as per DMRT; Where, T_1= Control, T_2= 24 hours water logging, T_3= 48 hours water logging, T_4= 72 hours water logging, V_1= Rajshahi Khoyeri, V_2= Kistotil Chapai, V_3= Kathtil Chapai, V_4= Gopalgonj MV-40, V_5= Gopalgong Black, V_6= Kalotil Gopalgong and V_7= Laltil Gopalgonj

CONCLUSION

Water logging generally affected growth and yield of sesame genotypes. However, four sesame genotypes *viz.*, Rajshahi khoyeri, Kistotil Chapai, Kathtil Chapai and Laltil Gopalgonj showed better tolerance to water logging than other three genotypes.

REFERENCES

Atkinson NJ, Lilley CJ, Urwin PE (2013) Identification of genes involved in the response of Arabidopsis to simultaneous biotic and abiotic stresses. *Plant Physiol*. 162(4), 2028-2041.

Bahmanyar MA (2007) The influence of continuous rice cultivation and different water logging periods on morphology, clay mineralogy, Eh, pH and K in paddy soils. *Pakistan J Boil. Sci.* 10(17), 2844-2849.

Bedigian D (2004) History and lore of sesame in Southwest Asia. *Econ Bot*. 2004; 58(3), 329–353.

Huang S, Greenway H, Colmer TD, Millar AH (2005) Protein synthesis by rice coleoptiles during prolonged anoxia: implications for glycolysis, growth and energy utilization. *Annals Bot*. 96(4), 703-715.

Islam MT, Hossain MS, Akter S (2006) Effect of waterlogging period on morphological attributes and yield of sesame. *J Bangladesh Soc. Agric. Sci. Technol*. 3(1 & 2), 163-156.

Komatsu S, Yamamoto R, Nanjo Y, Mikami Y, Yunokawa H, Sakata K (2009) A comprehensive analysis of the soybean genes and proteins expressed under flooding stress using transcriptome and proteome techniques. *J Proteome Res*. 8(10), 4766-4778.

Kozlowski TT (1984) Extent, causes and impact of flooding. In: Kozlowski, T.T. (Ed), Flooding and plant growth. Academic Press, London, pp: 1-5.

Miro B, Ismail AM (2013) Tolerance of anaerobic conditions caused by flooding during germination and early growth in rice (*Oryza sativa* L.). *Frontiers Plant Sci*. 4:269.

Miyahara Y, Komiya T, Katsuzaki H, Imai K, Nakagawa M, Ishi Y (2000) Sesamin and episesamin induce apoptosis in human lymphoid leukemia Molt 4B cells. *Int J Mol Med*. 6(1), 43-46.

Mondal N, Bhat KV, Srivastava PS (2010) Variation in Fatty Acid Composition in Indian Germplasm of Sesame. *J Am Oil Chem Soc.* 87(11), 1263-1269.

Nakano D, Kwak CJ, Fujii K, Ikemura K, Satake A, Ohkita M (2006) Sesamin metabolites induce an endothelial nitric oxide-dependent vasorelaxation through their antioxidative property-independent mechanisms: possible involvement of the metabolites in the antihypertensive effect of sesamin. *J Pharmacol Exp Ther*. 318(1), 328–335.

Nakashima K, Ito Y, Yamaguchi-Shinozaki K (2009) Transcriptional regulatory networks in response to abiotic stresses in Arabidopsis and grasses. Plant Physiol. 149(1), 88-95.

Ram R, Catlin D, Romero J, Cowley C (1990) Sesame: New approaches for crop improvement In: Simon JJaJE, ed. Advances in new crops. Portland, OR: Timber Press; p. 225-228.

Rasmussen S, Barah P, Suarez-Rodriguez MC, Bressendorff S, Friis P, Costantino P (2013) Transcriptome responses to combinations of stresses in Arabidopsis. Plant Physiol. 161(4), 1783–1794.

Sachs MM, Freeling M, Okimoto R (1980) The anaerobic proteins of maize. *Cell*. 20(3), 761-767.

Sarker PK, Khatun A, Singha A (2016) Effect of duration of water-logging on crop stand and yield of sesame. *Int J Innovation Applied Studies*. 14(1), 1-6.

Wang L, Zhang Y, Li D, Zhang X, Lv H, Wel W, Sun J, Zhang X (2011) Water logging effect and evaluation method on water logging tolerance of germinated sesame. *Chinese J Oil Crop Sci*. 33(6), 588.

Wang L, Zhang Y, Qi X, Li D, Wei W, Zhang X (2012) Global gene expression responses to water logging in roots of sesame (*Sesamum indicum* L.). *Acta Physiol Plant*. 34(6), 2241–2249.

Wang W, Zheng Y, Mei H, Zhang F (2000) Studies on response to water logging and adaptive changes in sesame (*Sesamum indicum* L.). II. Effects of water logging and growth regulators on physiological traits of some sesame genotypes. *Chinese J Oil Crop Sci*. 22(2), 48-52.

Wei W, Li D, Wang L, Ding X, Zhang Y, Gao Y (2013) Morpho-anatomical and physiological responses to water logging of sesame (*Sesamum indicum* L.). *Plant sci*. 208:102-111.