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Effect of stress mitigating compound on biochemical and quality parameters of groundnut (*Arachis hypogea* L.)

AD Thombare, AV Mane, MM Burondkar, MC Kasture and SS Desai

AD Thombare
Department of Agricultural Botany, College of Agriculture, Dr. Balasaheb Sawant Konkan Krushi Vidyapeeth, Dapoli, Dist-Ratnagiri, Maharashtra, India

AV Mane
Department of Agricultural Botany, College of Agriculture, Dr. Balasaheb Sawant Konkan Krushi Vidyapeeth, Dapoli, Dist-Ratnagiri, Maharashtra, India

MM Burondkar
Department of Agricultural Botany, College of Agriculture, Dr. Balasaheb Sawant Konkan Krushi Vidyapeeth, Dapoli, Dist-Ratnagiri, Maharashtra, India

MC Kasture
Department of Agricultural Botany, College of Agriculture, Dr. Balasaheb Sawant Konkan Krushi Vidyapeeth, Dapoli, Dist-Ratnagiri, Maharashtra, India

SS Desai
Department of Agricultural Botany, College of Agriculture, Dr. Balasaheb Sawant Konkan Krushi Vidyapeeth, Dapoli, Dist-Ratnagiri, Maharashtra, India

Correspondence
MC Kasture
Department of Agricultural Botany, College of Agriculture, Dr. Balasaheb Sawant Konkan Krushi Vidyapeeth, Dapoli, Dist-Ratnagiri, Maharashtra, India

Abstract
A field experiment was conducted during *Rabi* season 2016-17 at Research Farm of Deprtment of Botany, Dapoli to know the effect of different stress mitigating compounds on morpho-physiological characters, yield and yield components in groundnut under water stress. Experiment was laid out in randomized block design with three replications that control (T1) recorded significantly total chlorophyll content and Chlorophyll stability index over all other treatments, Whereas, stressed plot (T2) recorded lower values for these parameters as compared to other stress mitigating treatments. Proline content at different stages indicated that control had significantly lower proline content as compared all other treatments whereas stressed plot (T2) had the maximum proline content. Membrane stability index at different growth stages indicated that control had significantly higher MSI as compared to other treatments. The data indicated that there were significant diffrences between different stress mitigating treatments with respect to oil and protein content. From the result indicated that the oil and protein content was higher in control as compared to other treatments. While, stressed plot significantly lower oil and protein content as compared to other treatments.

Key words: chlorophyll, groundnut, moisture stress, proline, stress mitigating compounds, membrane stability index.

Introduction
Groundnut (Arachis hypogea L.) is one of the most important oil seed crops of India and ranks first among the oil seed crops; groundnut is an important crop both for oil and food. It is originated from Brazil in South America. Groundnut belongs to the sub-family Papilionaceae of family Leguminaceae. It is the 13th most important food crop of the world. It is the world‟s 4th most important source of edible oil and 3rd most important source of vegetable protein. It is cultivated predominantly in tropics and subtropics. Groundnut is grown on 26.4 million hectares worldwide with a total production of 37.1 million metric tonnes and an average productivity of 1.4 metric tonnes ha-1. Developing countries constitute 97 per cent of the global area and 94 per cent of the global production of this crop. The production of groundnut is concentrated in Asia and Africa (56% and 40% of the global area and 68% and 25% of the global production, respectively). The major groundnut producing countries in the world are India, China, Nigeria, Senegal, Sudan, Burma and the United States of America. Out of the total area of 18.9 million tonnes in the world, these countries account for about 69 per cent of the area and 70 per cent of the production (Madhusudhana, 2013) [12].

In India groundnut is cultivated on nearly 4.19 million hectares area with 6.68 million tonnes production and average productivity of 1.59 tonnes ha-1(Anonymous, 2015) [2], while in Maharashtra state, it is cultivated on area of 1.96 lakh hectares with productivity of 1163 Kg ha-1 and production of 2.28 lakh tonnes during kharif season and 0.71 lakh hectares area and 0.97 lakh tonnes production with 1366 Kg ha-1 productivity during Rabi season 2013-2014 (Anonymous, 2014) [2]. The major groundnut growing districts in Maharashtra are Dhule, Satara, Kolhapur, Pune, Nashik, Ahmednagar, Parbhani and Jalgaon.

Among the various abiotic stresses, drought is the major factor that limits crop productivity worldwide In water-limiting environments, the decrease on growth and productivity results of osmotic effect, and different plant species appears to activate various physiological and biochemical mechanisms to endure the stress (Munns, 2002) [15]. Osmotic adjustment by organic solutes accumulation, reduction of photosynthetic activity (Valliyodan and Nguyen, 2006) [32] and changes on antioxidative metabolism (Lima *et al*., 2002) [11] are typical

physiological and biochemical responses to water stress.
Crop productivity is dependent on the interplay of various physiological, biochemical processes of plants and environment. The cause and effect relationship of these is difficult to understand mainly because of the complexities in understanding the interactions of several processes and functions in the field condition. An attempt has been made in this investigation to find out the biochemical changes due to the foliar application of different stress mitigating treatments in groundnut.

Material and Methods

The experiment was conducted during *Rabi* season 2016-2017, at Research farm of Department of Agricultural Botany, College of Agriculture,(Konkan krushi Vidyapeeth) Dapoli. The experiment was laid out in randomized block design with three replications. Treatments consists of foliarapplication in water stressed plots with KCl @ 1 per cent; Triacontanol @ 2.0 ml/l; Alachlor @ 20 ppm; Methanol @ 2 per cent; Kaoline @ 6 per cent; Atrazine @ 100 ppm; Nitrobenzene @ 20ppm; Salicylic acid @ 500 ppm; CCC @ 100 ppm and water spray alone. These treatments are compared with unstressed and stressed plots without spraying of stress mitigating compounds. Konkan Gaurav which is sutaible for both *Kharif* and *Rabi* season was selected for study. Seeds are sown in 30 cm rows at distance of 15 cm. The crop was sown on 13th December 2016. Periodic observation of growth and physiological changes was recorded. The research data was statistically analysed for interpretation.

Result and Discussion

Accumulation of proline in leaves has been shown to be an adaptive mechanism for tolerance to stress and a relationship between the magnitude of free proline accumulation and drought tolerance has been shown in barley genotypes (Singh *et al.*, 1972) [29]. Significant accumulation of free proline due to moisture and biological stresses has been reported in sugarcane by Rao and Ashokan (1978) [22], Singh (1980) [27] and Ho *et al*. (1984) [7]. Association of proline accumulation with dry matter production was evident especially under stress condition.In the present study, proline content increased in the stressed treatments. Accumulation of proline showed higher in the later stage of plant that is at 60 DAS, 90 DAS and at harvest. These results are in conformation with the findings of Reddi and Reddy (1995) [23] opined that accumulation of proline is greater in the later stage of drought stress and therefore its concentration considered a good indicator of moisture stress. Among the treatments, the stressed plot had significantly higher proline content as compared to all other treatments. Significantly higher proline content was recorded in the water stressed treatment followed by foliar spray of methanol (2 %) and kaolin (6 %). These results are similar with the findings of Patil *et al*. (2010) [20] and Shashidhar *et al.* (1981) [26] who observed that the genotypes with high potassium accumulation had higher proline content under moisture stress condition in groundnut. The higher proline accumulation was associated with higher potassium content as observed in maize (Mukarjee, 1974). High proline and its further accumulation under stress is known to act as storage compound for carbon and nitrogen (Bernett and Naylor, 1966) [4]. Rajgopal *et al.* (1977) observed that in unirrigated wheat crop, there was less NRA activity and more proline accumulation.
Higher photosynthetic rate is one of the factors for realizing higher productivity because it is expected to provide the raw material and the energy required for growth and development. In the present investigation, maximum chlorophyll content at all the growth stages of plant was recorded in T1 (control treatment). Study further reported that the chlorophyll was significantly reduces at all the growth stages in T2 where plant received irrigation at 15 days interval. These results are in agreement with the findings of Reddy and Rao (1968) [24] reported that drought stress decreased the levels of chlorophyll *a, b* and total chlorophyll. The decrease in chlorophyll was attributed to the inhibition of chlorophyll synthesis as well as to accelerated turnover of chlorophyll already present. The total chlorophyll observed significantly higher in foliar application of triacontanol (2m1/1) compared to other treatments like kaolin (6%), nitrobenzene (20ppm) and methanol (2%). Stressed plot recorded significantly lower total chlorophyll content. These results are in agreement with the findings of Naeem and Khan (2005) [16]. Naeem *et al*. (2009) [17] showed that TRIA improved or show positive response by improving chlorophyll content and carotenoid content in Hyacinth bean (*Lablab purpureus* L.)
Moisture stress is reported to cause decrease in water potential, relative water content, chlorophyll stability index and increase in peroxidase activity (Tyagi *et al*., 1999; Mandal and Singh. 2000) [30, 13]. In present investigation, among the treatments triacontanol (2.0m1/1) recorded significantly more chlorophyll stability index compared to other treatments followed by methanol (2 %) and kaolin (6 %) at 30 DAS. The chlorophyll stability index observed lowest in stressed plot followed by alachlor (20 ppm). A similar trend continued at 60 and 90 DAS. Similarly Reddy *et al*. (2003) [25] screened six cultivars of groundnut by considering relative drought tolerance based on the chlorophyll stability index (CSI), membrane stability index (MSI), peroxidase activity and ash content. CSI and ash content showed significant and positive correlation. Whereas, MSI and peroxidase activity showed significant negative, correlation with pod yield under moisture stress conditions.
The environmental stresses in plants affect cell membrane, which disturb its function partly or totally. The cellular membrane dysfunction due to stress can increase permeability and leakage of ions, which can be readily measured by efflux of electrolytes. Hence the estimation of cellular dysfunction under stress by measuring cellular electrolyte leakage from affected leaf tissue into an aqueous leaf medium is finding a growing use as cell membrane stability (CMS) and as a screen for stress resistance by Vaidya *et al.* (2015) [31]. In this study, at 30 DAS, among all the treatments, control and triacontanol (2.0m1/1) recorded significantly more membrane stability index followed by kaolin (6%), Nitrobenzene (200ppm) and KCl (1.0%). These results were in conformity with the findings of Lesniak *et al*. (1986, 1989) [9-10] were TRIA affected several other enzyme systems especially the membrane bound Ca2+/Mg2+ dependent ATPase in peanut. The membrane stability index was less in stressed plot followed by foliar application of water, atrazine (100ppm) and alachlor (20 ppm). Membrane stability index was increased 30 to 60 DAS but after this it decreases up to harvest. A similar trend continued at 30, 60, 90 DAS and at harvest. These finding are in conformity with findings of Chakraborty *et al.* (2015) [5] studied that the cultivar ICGV 86031 and DRG 1 showed highest reduction in MSI at pegging and pod development stages, respectively. Similar result obtained by Vaidya *et al.* (2015) [31] in groundnut crop.
Groundnut seed contains approximately 50 % oil. Generally, oleic and linoleic acid together make up 80 % of the fatty

acids in groundnut oil. Groundnut storage qualities and nutritional quality are both dependent on the relative proportion of saturated and unsaturated fatty acids in the oil. If oleic: linoleic acid ratio decreased then it results in less stable oil. Lower oil content and protein was recorded by water stressed plot as compare to all other treatments. These results are in conformity with the finding of Dutta and Modat (2006) [6] that water stress due to withholding of irrigation at different stage of crop growth affect the oil content of groundnut. Similarly, drought significantly decreased oil content and more reduction was observed when stress was applied at anthesis stage reported by Hussain *et al*. (2013) [8] and Paknejad *et al*. (2012) [19]. In the present study, among different stress mitigating treatments foliar spray of triacontanol (2.0 ml/l) recorded higher oil content and protein content. These results are in conformity with findings of Naeem and khan *et al*. (2005, 2009) [16-17] that application of TRIA improve seed protein content in hyacinth bean.

Table 1: Effect of stress mitigating compound on proline content of groundnut under moisture stress condition.

Tr. No.	Treatments	Proline content			
		30 DAS	60 DAS	90 DAS	At harvest
T_1	Control(normal irrigation) 7days interval	33.59	38.34	41.64	69.26
T_2	Stress plot (15 days irrigation)	88.44	98.71	127.84	133.11
T_3	T_2+ Foliar application of KCl (1%)	56.65	61.11	86.68	110.64
T_4	T_2+ Foliar application of Triacontanol (2ml/l)	54.70	67.72	84.25	98.81
T_5	T_2 + Foliar application of Alachlor (20 ppm)	53.82	62.39	78.95	94.19
T_6	T_2+ Foliar application of Methanol (2%)	60.79	65.34	78.02	97.42
T_7	T_2+ Foliar application of Kaolin (6%)	64.87	64.81	77.86	94.05
T_8	T_2+ Foliar application of Atrazine(100ppm)	57.57	64.23	78.30	95.19
T_9	T_2+ Foliar application of Nitrobenzene (20ppm)	58.51	66.49	79.80	97.47
T_{10}	T_2+ Foliar application of Salicylic acid (500ppm)	54.77	62.27	76.03	95.80
T_{11}	T_2+ Foliar application of CCC (100ppm)	53.59	63.87	76.30	95.34
T_{12}	T_2+ Foliar application of water	60.19	60.61	84.13	99.33
S.E.±		1.72	1.91	2.65	2.89
C.D. (P=0.05)		5.04	5.62	7.78	8.47

Table 2: Effect of stress mitigating compound on Chlorophyll content of groundnut under moisture stress condition.

Tr. No.	Treatments	Chlorophyll content mg/g			
		30 DAS	60 DAS	90 DAS	At harvest
T_1	Control(normal irrigation) 7 days interval	2.38	2.83	2.83	2.27
T_2	Stress plot (15 days irrigation)	1.31	1.51	1.51	1.61
T_3	T_2+ Foliar application of KCl (1%)	2.02	2.19	2.76	1.82
T_4	T_2+ Foliar application of Triacontanol (2ml/l)	1.65	2.76	2.76	1.98
T_5	T_2 + Foliar application of Alachlor (20 ppm)	1.49	2.29	2.29	2.03
T_6	T_2+ Foliar application of Methanol (2%)	2.05	2.54	2.54	1.87
T_7	T_2+ Foliar application of Kaolin (6%)	1.69	2.10	2.10	1.91
T_8	T_2+ Foliar application of Atrazine(100ppm)	1.52	2.23	2.23	2.02
T_9	T_2+ Foliar application of Nitrobenzene (20ppm)	1.33	2.78	2.78	2.11
T_{10}	T_2+ Foliar application of Salicylic acid (500ppm)	1.62	2.37	2.37	1.98
T_{11}	T_2+ Foliar application of CCC (100ppm)	1.75	1.32	1.33	1.79
T_{12}	T_2+ Foliar application of water	1.37	2.32	2.29	1.68
S.E.±		008	0.16	0.09	0.08
C.D. (P=0.05)		0.24	0.46	0.26	0.22

Table 3: Effect of stress mitigating compound on Chlorophyll stability index and membrane stability index of groundnut under moisture stress condition.

Tr. No.	Treatments	Chlorophyll stability index				Membrane stability index (%)			
		30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
T_1	Control(normal irrigation) 7 days interval	69.15	71.72	73.72	76.72	83.07	86.46	88.89	72.04
T_2	Stress plot (15 days irrigation)	60.50	69.89	69.83	71.76	72.85	75.22	79.85	64.32
T_3	T_2+ Foliar application of KCl (1%)	65.73	69.36	71.89	68.17	80.73	84.28	85.86	70.92
T_4	T_2+ Foliar application of Triacontanol (2ml/l)	68.60	71.50	73.17	75.16	82.88	85.80	87.94	71.90
T_5	T_2 + Foliar application of Alachlor (20 ppm)	63.97	64.31	67.32	72.83	79.35	82.96	84.18	69.46
T_6	T_2+ Foliar application of Methanol (2%)	67.52	70.57	70.86	74.36	78.92	82.25	83.57	68.86
T_7	T_2+ Foliar application of Kaolin (6%)	66.75	71.03	73.03	75.57	82.49	85.11	87.04	71.47
T_8	T_2+ Foliar application of Atrazine(100ppm)	63.83	67.09	68.46	70.80	78.18	81.91	83.22	68.29
T_9	T_2+ Foliar application of Nitrobenzene (20ppm)	67.40	68.86	71.36	76.03	81.52	84.87	86.69	71.03
T_{10}	T_2+ Foliar application of Salicylic acid (500ppm)	65.55	67.83	72.57	74.37	80.42	83.76	85.15	70.03
T_{11}	T_2+ Foliar application of CCC (100ppm)	64.46	65.32	69.09	73.86	79.93	83.15	84.93	69.82

T_{12}	T_2+ Foliar application of water	61.04	66.46	65.51	70.32	77.51	81.38	81.94	67.72
S.E.±		1.80	1.59	1.67	1.66	1.72	1.84	0.95	0.93
C.D. (P=0.05)		5.29	4.66	4.90	4.87	5.05	5.40	2.77	2.72

Table 4: Effect of str ess mitigating compound on quality parameters of groundnut under moisture stress condition.

Tr. No.	Treatments	Quality parameters	
		Oil Content (%)	Protein Content (%)
T_1	Control(normal irrigation) 7 days interval	46.49	25.01
T_2	Stress plot (15 days irrigation)	38.20	20.41
T_3	T_2+ Foliar application of KCl (1%)	44.81	24.35
T_4	T_2+ Foliar application of Triacontanol (2ml/l)	45.66	24.80
T_5	T_2 + Foliar application of Alachlor (20 ppm)	43.00	22.92
T_6	T_2+ Foliar application of Methanol (2%)	43.41	23.80
T_7	T_2+ Foliar application of Kaolin (6%)	44.66	24.02
T_8	T_2+ Foliar application of Atrazine(100ppm)	42.78	22.45
T_9	T_2+ Foliar application of Nitrobenzene (20ppm)	41.25	23.23
T_{10}	T_2+ Foliar application of Salicylic acid (500ppm)	42.27	21.90
T_{11}	T_2+ Foliar application of CCC (100ppm)	43.87	22.44
T_{12}	T_2+ Foliar application of water	40.72	21.57
Mean		43.09	23.08
S.E.M±		1.44	0.88
C.D. (P=0.05)		4.23	2.59

Conclusion

From the results of investigation, it is concluded that foliar application of triacontanol (2ml/l) for all growth and yield parameters was numerically less than normal irrigation but it was statistically at par almost all stages of plant growth. So, triacontanol showed effective to mitigate the ill effect of water stress.

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