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Determination of the effect of foliar spray of sugar & salt solution on different agro morphological characters of Kalmegh plant in field condition

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Abstract

Kalmegh is well known for its medicinal properties due to andrographolide contents. This experiment was conducted to determine the best response against salt and sugar stress. Growth parameter were studied under this study viz- Plant height, No. of nodes/plant, Branch/plant, Branch length/plant, No. of leaf, Leaf area, Fresh weight, Dry weight. findings showed the genotypes significantly differs for all the plant characters. This result suggested diverse nature of genotypes and established the validity of assumption of employing viz- genotypes and in present study. In case of variety × treatment interaction all parameters showed significant except plant height, branch no/plant & branch length in Control, Sugar and Salt treatments.

Keywords: kalmegh, variety, salt, sugar and stress

Introduction

The great king of bitter is known as Kalmegh (*Andrographis paniculata*), belongs to Acanthaceae Family, is a very well known medicinal plant, highly utilized in both ayurvedic and homoeopathic medicine processing in India as well as all over the world (Niranjan *et al.* 2010). Kalmegh is one of the nineteen species of the genus *Andrographis*, which is indigenous to India (Bhattacharya *et al.* 2012). It is distributed in tropical Asian countries having hot and humid climatic conditions but it can be cultivated in subtropical regions during the monsoon season (Kumar, 2011). Soil salinity is one of the major environmental stress factors that causes many adverse effects on growth and productivity of plants. Soils are known as saline when the EC is 4 dSm⁻¹ or more, which generates an osmotic pressure (Munns and Tester, 2008). Soil salinity is a global issue and more than 6% of land of the world is salt affected. Productivity of plants in arid and semiarid regions of the world is very low due to soil salinity (Ashraf *et al.*, 2002; Munns, 2002; Munns and Tester, 2008). Salt tolerance threshold is a critical parameter for measuring plant salt tolerance, which is generally known as the relative yield response to increasing salinity in root zone; exposed to saline water (Maas, 1990). The salinity tolerance threshold is a specific target for improving plant salt stress tolerance. To understand the salt tolerance mechanisms, it is necessary to understand whether the growth and yield reduction is due to osmotic effect of salinity, or the toxic effect of certain ions accumulated within the plant. The reduction in growth occurs in two specific phases. The first, phase (osmotic phase) is a rapid response, where the growth starts to decrease immediately after the salt concentration around the roots increased. This will identify the threshold level of plant. The salinity threshold level is approximately 40 mM NaCl (~ 4 dSm⁻¹) for most plants. The second salinity response (ion toxicity phase) is slower, which is normally due to the accumulation of Na⁺ in the old leaves. The latter response causes a significant reduction of yield, due to the leaf death. In this case the photosynthetic capacity of the plant will no longer be able to provide the required carbohydrate of the young leaves, which causes further reduction in growth rate (Maggio *et al.*, 2007; Munns and Tester, 2008). In many salt sensitive plants, a major part of the growth inhibition is caused by excessive Na⁺ (Jaleel *et al.*, 2007). The high sodium disturbs the potassium (K⁺) nutrition, when sodium is accumulated in the cytoplasm and inhibits the activity of many enzymes (Jaleel *et al.*, 2007). This experiment aimed at Determination of the effect of foliar spray of sugar & salt solution on different agro morphological characters of Kalmegh plant in field condition.

Material and methods

The field experiment entitled "Effect of some growth regulators, sugar and salt solution on

different agro morphological characters of Kalmegh (*Andrographis paniculata*) was conducted at experimental farm of University of Calcutta at Baruipur, South 24-parganas in West Bengal situated at Latitude – 22.22° N, Longitude – 88.26°E, Altitude – 9.75 msl (above mean sea level) during the year 2012 - 2013. The field experiment started with seed sowing on 29th of October, 2012. The soil of experimental plot was medium fertility, clay loam in texture (Sand-16.20, Silt-27.30 and Clay-50.50 %), nearly neutral in reaction more or less representative of the new gangetic alluvium in the delta region of West Bengal. The physico-chemical analysis of the composite soil sample was done using International pipette method (piper, 1950) in the soil science laboratory, Institute of Agricultural science, University of Calcutta. Organic carbon - 0.90% (Volumetric method, Walkley & Black, 1947), Total nitrogen - 0.08% (Alkaline permanganate method, Jackson,1973), Total phosphorus - 2500ppm and Available phosphorus - 24ppm (Bray's method, Bray & Kurtz,1945), Total potassium - 82100ppm and Available potassium - 220ppm (Flame photometer methods, Jackson,1973), Cation exchange capacity-21.80m.e/100g. of soil, Exchangeable Calcium- 16.80m.e/100g of soil, Exchangeable magnesium-9.10m.e/100g. of soil, pH (Water extract 1:2.5) - 6.60 (Jackson,1973), Conductivity (Water extract 1:5) - 0.143m.mohs/cmm, Bulk density (g cc⁻¹) (Bodman, 1942), Field capacity (%) (Coleman, 1944).

Results and discussion

Plant growth is one of the major agricultural indices of salt stress tolerance as indicated by different studies (Munns, 2002). Treatment effect on growth parameters has been estimated over control. From, data analysis, we come to know that foliar spray of Sugar and Salt solutions have pronounced effects over control. In this experiment sugar and salt both have reduced the plant height in respect of control, whereas salt solution treatment has reduced most. Plant height Shyam Nagar local variety produced highest plant height, where as Sarisha local stood second and N.B.R.I (Lucknow) has grown to minimum height. The inhibition of plant growth under salt stress could be due to either reduction of osmotic on water absorption or extreme accumulation of ions, known as specific ion effect. Low level of salinity facilitated morphological traits in *A. paniculata*, similar to the results of Rajpar *et al.* (2007). No. of nodes /plant is maximum in case of Sarisha local, second one is Majhdia local, where as Mednipur local is showing minimum no. of nodes/plant. Foliar spray of Sugar has increased the no. of nodes and thereby reduced the intermodal distance in respect of control, whereas salt solution treatment has reduced no. of node than control. In case of average branch no/plant Sarisha local has produced maximum branches, followed by Majhdia local, Shyam Nagar local and minimum in case of Barasat local. Sugar has reduced the branch no./ plant in respect of control, whereas sugar solution treatment has reduced branch no. than control. In case of branch length Majhdia local is showing maximum enlargement followed by Shyam Nagar local, whereas N.B.R.I (Lucknow) extended to minimum among them. Sugar and salt solutions have almost maintained the values like control, whereas salt solution treatment has little

bit increased the branch length than control. No. of leaf/plant is also maximum in Sarisha local, followed by Majhdia local. Minimum leaf no. is recorded in case of Shyam Nagar local. Similarly, both Sugar and Salt solutions have reduced the no. of leaf per plant in respect of control, whereas Salt solution treatment has reduced most among the three conditions. The parameter leaf area in six varieties- Shyam Nagar local has highest extension, preceding Majhdia local, N.B.R.I(Lucknow), Mednipur local, Sarisha local, and Barasat local. Foliar spray of Sugar and Salt solutions have enhanced the leaf area in respect of control, whereas Salt solution treatment has increased its maximum. Fresh weight/plant is recorded maximum in Sarisha local, then Shyam Nagar local, Majhdia local, Mednipur local, Barasat local have developed almost equal amount of fresh weight, whereas has N.B.R.I(Lucknow) minimum mass. Decrease in number of leaves and leaf area agreed with the evidence documented by Ismail *et al.* (2015) The width and length of *A. paniculata* leaves decreased, which resulted by salt toxicity. Additionally, prolonged exposure lead to ion toxicity which inhibits development of new leaves (cell division), stomatal closure (photosynthesis activities) and eventually died of old leaves. Sugar and Salt solutions have enhanced the fresh weight in respect of control, whereas Sugar solution treatment has increased its maximum. After being dried like fresh weight Shyam Nagar local is at the top rank, then Sarisha local, Mednipur local, Majhdia local, Barasat local and minimum weight is N.B.R.I (Lucknow) recorded. Both (Sugar and Salt) solutions have enhanced the dry weight like fresh weight in respect of control, whereas Sugar solution treatment has increased its maximum as observed in fresh condition. This findings were similar with Talei *et al.* (2012) 44 – 78 % less dry weight were found in high salinity level in different cultivars of kalmegh. An increased biomass is usually recognized as a general response to salinity and may improve salinity tolerance by restricting the instability of toxic ions to the shoots and roots. Water soluble extractive w/w is recorded highest percentage Sarisha local, Barasat local stood second, Shyam Nagar local has minimum. Enhanced levels of the water soluble extractive in respect of control were found in both Sugar and Salt treated plants. Sugar treatment performed best. Alcohol soluble extractive w/w is recorded highest percentage Sarisha local, Shyam Nagar local and N.B.R.I (Lucknow). From, above findings and data analysis, we come to know that foliar spray of both Sugar and Salt solutions have enhanced the water soluble extractive in respect of control. Sugar treatment performed best. As, we know that stressed conditions can reduce growth parameters but on the other hand can enhance dry matter accumulation as well as active ingredient synthesis therefore all estimated data may follow the same. Abiotic stress like salinity can improve medicinal properties of medicinal plant. Again, synthesis of lactone like- secondary metabolite is indirectly related with sugar digestion through mevalonic acid pathway. Therefore by imposition of salinity the andrographolide (a diterpenoid lactone) contain can be increased and in same line of thought by providing extra sugar from outside the same can be enhance.

Table 1: Effect of sugar and salt treatments on plant height (cm) of kalmegh.

Treatments	Control	Sugar	Salt	Mean
Sarisha local	60.66	57.33	54.33	57.44
N.B.R.I.	45.00	45.33	45.33	45.22

Barasat local	57.66	50.66	43.66	50.66
Mednipur local	56.66	48.66	51.00	52.11
Majhdia local	53.33	56.33	52.33	54.00
Shyamnagar local	62.33	54.33	60.00	58.88
Mean	55.94	52.11	51.11	
CD at 5% Level of significance		Variety 6.40*	Treatment 4.53 ^{NS}	(V × T) 11.09 ^{NS}

Table 2: Effect of sugar and salt treatments on number of nodes of kalmegh.

Varieties	Treatments			Mean
	Control	Sugar	Salt	
Sarisha local	15.66	12.00	12.00	13.22
N.B.R.I.	8.33	9.00	5.66	7.66
Barasat local	7.00	7.00	6.00	6.66
Mednipur local	6.33	5.00	8.33	6.55
Majhdia local	8.66	17.00	7.66	11.11
Shyamnagar local	10.00	8.66	10.33	9.66
Mean	9.33	9.77	8.33	
CD at 5% Level of significance		Variety 2.16*	Treatment 1.53 ^{NS}	(V × T) 3.74*

Table 3: Effect of sugar and salt treatments on number of branches/plant in kalmegh.

Varieties	Treatments			Mean
	Control	Sugar	Salt	
Sarisha local	13.66	14.00	12.00	13.22
N.B.R.I.	10.33	7.33	6.33	8.00
Barasat local	9.33	5.66	5.00	6.66
Mednipur local	9.33	7.66	10.66	9.22
Majhdia local	11.00	12.00	9.33	10.77
Shyamnagar local	11.00	7.33	11.33	9.88
Mean	10.77	9.00	9.11	
CD at 5% Level of significance		Variety 2.75*	Treatment 1.94 ^{NS}	(V × T) 4.76 ^{NS}

Table 4: Effect of sugar and salt treatments on branch length of kalmegh.

Varieties	Treatments			Mean
	Control	Sugar	Salt	
Sarisha local	31.91	34.89	32.24	33.01
N.B.R.I.	23.58	26.36	28.48	26.14
Barasat local	34.28	33.19	29.07	32.18
Mednipur local	34.90	34.59	29.22	32.90
Majhdia local	36.26	27.48	47.49	37.07
Shyamnagar local	35.26	35.74	33.49	34.83
Mean	32.70	32.04	33.33	
CD at 5% Level of significance		Variety 8.06 ^{NS}	Treatment 5.70 ^{NS}	(V × T) 13.97 ^{NS}

Table 5: Effect of sugar and salt treatments on number of leaves of kalmegh.

Varieties	Treatments			Mean
	Control	Sugar	Salt	
Sarisha local	427.33	341.33	300.00	356.22
N.B.R.I.	168.66	152.00	73.33	131.33
Barasat local	130.66	84.00	61.33	92.00
Mednipur local	118.66	78.00	179.33	125.33
Majhdia local	194.66	390.00	142.66	242.44
Shyamnagar local	220.00	134.66	254.66	203.11
Mean	210.00	196.66	168.55	
CD at 5% Level of significance		Variety 84.46*	Treatment 59.72 ^{NS}	(V × T) 146.29*

Table 6: Effect of sugar and salt treatments on leaf area (mm²) of kalmegh.

Treatments Varieties	Control	Sugar	Salt	Mean
Sarisha local	288.33	292.00	365.33	315.22
N.B.R.I.	336.66	377.33	502.00	405.33
Barasat local	214.00	253.33	200.00	222.44
Mednipur local	290.00	370.66	285.33	315.33
Majhdia local	327.33	408.66	568.00	434.66
Shyamnagar local	456.66	500.00	409.33	455.33
Mean	318.83	367.00	388.33	
CD at 5% Level of significance		Variety	Treatment	(V × T)
		74.35*	52.57*	128.78*

Table 7: Effect of sugar and salt treatments on fresh weight (g) of kalmegh.

Treatments Varieties	Control	Sugar	Salt	Mean
Sarisha local	34.23	43.26	34.49	37.33
N.B.R.I.	16.90	18.95	18.36	18.07
Barasat local	23.20	28.29	20.25	23.91
Mednipur local	28.53	30.71	24.08	27.77
Majhdia local	22.22	28.14	37.66	29.34
Shyamnagar local	35.06	34.33	37.16	35.52
Mean	26.69	30.61	28.67	
CD at 5% Level of significance		Variety	Treatment	(V × T)
		2.64*	1.87*	4.58*

Table 8: Effect of sugar and salt treatments on dry weight (g) of kalmegh.

Treatments Varieties	Control	Sugar	Salt	Mean
Sarisha local	18.00	24.23	18.35	20.19
N.B.R.I.	8.13	9.32	9.41	8.95
Barasat local	16.74	20.02	11.99	16.25
Mednipur local	19.22	20.61	16.06	18.63
Majhdia local	12.08	17.91	24.80	18.26
Shyamnagar local	21.88	24.59	24.48	23.65
Mean	16.01	19.45	17.52	
CD at 5% Level of significance		Variety	Treatment	(V × T)
		2.24*	1.58*	3.88*

Table 9: Effect of sugar and salt treatments on water soluble extractive w/w of kalmegh.

Treatments Varieties	Control	Sugar	Salt	Mean
Sarisha local	12.69	16.38	12.00	13.69
N.B.R.I.	10.95	16.05	10.93	12.64
Barasat local	11.50	13.76	15.68	13.64
Mednipur local	13.90	14.33	12.26	13.50
Majhdia local	11.56	12.00	12.98	12.18
Shyamnagar local	12.00	11.66	11.70	11.78
Mean	12.12	14.00	12.59	
CD at 5% Level of significance		Variety	Treatment	(V × T)
		1.49*	1.05*	2.58*

Table 10: Effect of sugar and salt treatments on alcohol soluble extractive w/w of kalmegh.

Treatments Varieties	Control	Sugar	Salt	Mean
Sarisha local	7.72	8.37	8.50	8.20
N.B.R.I.	5.37	8.04	6.52	6.64
Barasat local	5.90	7.93	8.14	7.26
Mednipur local	7.98	7.74	4.59	6.77
Majhdia local	6.32	6.26	8.37	6.98
Shyamnagar local	6.69	8.62	7.31	7.54
Mean	6.63	7.83	7.22	
CD at 5% Level of significance		Variety	Treatment	(V × T)
		1.00*	0.71*	1.74*

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