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National Academy of Agricultural Science (NAAS) Rating : 3. 03

Effect of Potassium Solublizing Bacteria Utilization on Sesame Growth and Development

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Abstract: *In order to compare the effects of K sources and sesame cultivars and yield and yield components in 3 cultivars of sesame, the pot experiment was done in 2014 at Arak research station Arak, Iran in split plots as a randomized complete block design with 12 treatments and 3 replications during 2014. The main plots were 4 levels of K applications included chemical potassium sulfate, K solublizing bacteria1 and 2 and mixed of ksb1 and 2, and in subplots we had 3 cultivars of sesames includes Ultan, Yekta and Dashtestan 2. The results showed that the significantly change in sesame dry weight at 75 and 90 days after sowing, height at 45 days after sown and 1000 seed weight and seed yield and oil content were achieve. The significant changes in 1000 seed weight was obtain at 1% statistical level of meaningful for cultivars treatment. In highest seed yield was obtain by Yekta cultivar with 18.62 g/plant. In this research the Yekta cultivar by produce oil contents by 46.08 % get record.*

Key words*: cultivars, potassium solublizing bacteria, sesame, yield.*

INTRODUCTION

Sesame (*Sesamum indicum* L.) is one of the most important oilseed crops in the world. The cultivated types of sesame originated in India. The sesame seeds include high content of oil as well as protein. Sesame varieties have adapted in many soil types. Sesame crops can grow in fertile soils and neutral pH but in poor soils and the best yields come from properly NPK fertilized farms. There are four phases in the development of sesame excluding the ripening phase are divided into stages based upon events which can be identified. With this information, to produce maximum yield timely applications of potassium is useful as well as nitrogen. Sesame with an extensive root system is able to use of available nutrients and absorb mobile nutrients from deep parts of soil (6). Thus, the highest yields are with a balance of NPK nutrients and their availability. K (K2O) is one of the macro important nutrients to plant growth and development, and K deficiencies can lead to poor yields (9). Potassium balance is important for vegetative plant parts such as the stem and lateral stems (2).

In most irrigated sesame growing areas, K is one of the limiting factors. The major amounts of K, naturally find as containing in soil minerals. K in alkaline soils rapidly fixed and changes it to a special form which is not directly taken up by the plant roots. New studies showed that a group of microorganisms in soils which named the potassium solublizing bacteria (KSB) same as Bacillus mucilaginosus, B. edaphicus, B. circulans, Acidothiobacillus ferrooxidans, Paenibacillus spp., can improve this problems (8). The main mechanism of KSBs regards to solubilize the insoluble potassium (K) to soluble K by acidolysis, chelation, exchange reactions, complexolysis and production of organic acid mechanisms. To increase sesame production the planting seeds in poor soils with low fertility of essential nutrients such as K is a real solution.

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MATERIALS AND METHODS

A field experiments was conducted during 2014 at the research farm of faculty of agriculture (34°03′10" N, 49°48′15" E, altitude 1690m above mean sea level), Islamic Azad University, Arak, Iran to study the effect of potassium solublizing bacteria utilization on sesame growth and development.

The experiment included 12 treatments which were the combinations of four levels of mineral and KSB bio-fertilizer, chemical potassium sulfate (48% K2O : 8 g/kg soil as control), ksb1(*Bacillus circulans* L.), ksb2 (*Bacillus megatherium* L.) and ksb1+ksb2 as soil application and three sesame cultivars Ultan, Yekta and Dashtestan2. The experimental design was split plots with three replications. Four levels of mineral and bio-KSB fertilizer were arranged randomly in the main plots, while three sesame cultivars were distributed randomly in the sub plots. Each experimental sup plot consisted of 12 plants in each 5.0 kg soil capacity plastic pots in outdoor condition. Seeds were sown on July 10. After 10 days from sowing, ksb fertilizers were applicant. Basal nitrogen in the form of Urea (46% N) at the rate of 4.5 gN/pot was applied at three times of sowing time, after 30 and 60 days from sowing date. Phosphorus in the form of Amonium phosphate (50% P2O5) was applied by mixed with the soil in the pot filling time at rate of 8 g P2O5/ pot. Biofertilizer (Potabarvar®) contained K solublizing bacteria namely *Bacillus circulans* L. strain ksb1 and *Bacillus megatherium* L. ksb2 were inoculated in soil immediately after sowing. A plant samples were randomly taken from each pots after 30, 45, 60, 75 90 and 105 from sowing and TDM (g/plant), plant height (cm) estimations and in final maturity stage (120 days after sowing) number of branches and capsules/plant, 1000-seed weight (g), seed yield/plant (g) were measured. To determination of seed oil content (%) A.O.A.C. (1) method was used.

The analysis of variance of split plot design was used according to SAS 9.1 and Means comparison was according to least significant different (LSD) at the 5% level of significance.

The soil of the experiments was sandy loam with the pH, 7.22, O.C, 0.88% (10), available P 11.98 ppm (3); available K, 68.78 ppm (7) and organic matter, 0.08% (1).

RESULTS AND DISCUSSION

Effect of Potassium fertilizers

Data in Table 1,3 and 5 make known that different sources of K fertilizer from K1 to K4 significantly changed in sesame dry weight at 75 and 90 days after sowing, height at 45 days after sown and 1000 seed weight and seed yield and oil content, respectively. The number of branches and capsules per plant were not significantly changes.

The changes in sesame dry weight appear when the plants had 75 days at least. Application of ksb2 could significant increase sesame dry weight by 0.9% i.e.10.7 g/plant compare to 10.26g/plant (in control). At 90 days after planting, also, the ksb2 and ksb3 and chemical potassium fertilizers had the same effect on dry weight by standing in the same group. In other words the chemical potassium fertilizer and ksb2 and ks3 that were mixed of ksb1 and ksb2 had the same or equal effect on dry weight in sesame cultivars (table 2).

Plant height in sesame was affected by ksb2 and ksb3 treatments 45 day after inoculation was the highest height in all three cultivars. The next 5 stages for plant height were not changes. It will be shown that the chemical potassium and ksb fertilizers place in the same group and show equal efficiency (table 4). These results also find for number of branches and capsules per plant , 1000 seed weight and seed yield and oil content which are the different potassium treatment levels sit in the same group of efficiency (table 6).

While, in the results the number of capsules/ plant of sesame was increased by ksb2 treatment compare to control from 86.27 to 97.21 but it need to more investigation (Tables 3 and 6). These results were expected the positive effect of ksb2 on number of capsules/plant might be due role of potassium in increases number of flowers/plant and capsules setting percentage (Marschner, 1986). Similar results were obtained by Mekki et al. (5) and Kalaiselvan et al. (4).

Table 1
Effect of K on sesame dry weight (TDM)

		MS for dry weight					
sov	*df*	*30 DAP*	*45 DAP*	*60 DAP*	*75 DAP*	*90 DAP*	*105 DAP*
Replication	2	0.108	0.999	0.461	1.322	61.724	16.444
Potassium (K)	3	0.083ns	0.870ns	0.505ns	1.913*	77.333*	3.188ns
Cultivars (V)	2	0.009ns	0.129ns	0.370ns	0.166ns	34.004ns	29.843**
Interaction (K.V)	6	0.216*	4.715*	0.772ns	1.629ns	80.071ns	7.656ns
Error	22	0.120	1.324	0.353	0.947	40.181	4.031
CV%		11.645	20.205	7.936	9.458	43.33	8.472

NS, * = non-significant and significant probability level at 5%, respectively.

Table 2
Mean comparison of sesame dry weights

	Means of dry weight					
Treatments	*30 DAP*	*45 DAP*	*60 DAP*	*75 DAP*	*90 DAP*	*105 DAP*
K1(Potassium sulfate)	3.011	6.005	7.844	10.265ab	18.667a	23.908
K2(*Bacillus circulans* L.)	3.075	5.360	7.322	9.653b	11.881b	22.917
K3(*Bacillus megatherium* L.)	2.846	5.510	7.388	10.708a	13.244 ab	24.335
K4 (B. *circulans*+ *B. megatherium*)	2.945	5.614	7.291	10.295ab	16.530 ab	23.012
V1)Ultan)	2.981	5.813	7.591	10.403	13.333	22.585b
V2 (Yekta)	3.000	5.663	7.600	10.168	14.017	25.505a
V3 (Dashtestan 2)	2.836ab	5.590abc	7.133b	10.653a	11.010ab	23.820c
K1V1	3.216ab	6.533abc	8.000ab	10.610a	13.800ab	23.793bc
K1V2	3.210ab	5.613abc	7.133b	10.320ab	19.333ab	23.310bc
K1V3	3.063ab	6.713ab	7.600ab	10.363ab	23.000a	22.027bc
K2V1	2.820ab	6.866bc	7.466ab	9.573ab	18.667ab	22.070bc
K2V2	3.150ab	6.436abc	8.466a	10.860a	14.333ab	27.630a
K2V3	3.063ab	4.286 c	6.866b	9.530ab	10.777ab	22.067bc
K3V1	3.223 a	7.286 a	7.866 ab	10.810a	13.533ab	20.947c
K3V2	3.110ab	4.506 bc	7.233b	8.620b	11.333ab	25.740ab
K3V3	2.820ab	5.866abc	7.566ab	10.633a	21.333a	24.137abc
K4V1	3.000 b	6.566bc	7.033b	10.620a	7.333b	23.530bc
K4V2	3.153ab	6.096abc	7.566ab	10.873a	11.067ab	25.340ab
K4V3	3.011	6.005	7.844	10.265ab	18.667a	23.908

Sesame cultivar reactions

Data in Table 1, 3 and 5 make known that different sesame cultivars significantly were the cause for change in sesame dry weight at 105 days after sowing, 1000 seed weight and seed yield and oil content, respectively. In this experiment all three sesames cultivar were the same characteristics in case of number of branches and capsules per plant. The changes in sesame dry weight at final growth stage were come out at 105 days after sowing. Yekta cultivar was the highest dry weight by 25.5 g/plant by means of that it was 3.0 g more than closest cultivar to it (Ultan). In other words, the response of cultivars to different sources of potassium fertilizer is significantly different in biomass accumulation compare to earlier plant growth stages (table 2). The plant height was

Table 3
Effect of K on sesame plant height

sov	df	MS for height					
		30 DAP	45 DAP	60 DAP	75 DAP	90 DAP	105 DAP
Replication	2	968.702	179.111	263.444	109.373	0.667	178.062
Potassium (K)	3	22.938*	145.370ns	162.398ns	400.443ns	3.901ns	262.320ns
Cultivars (V)	2	49.593ns	100.027ns	161.777ns	273.515ns	2.494ns	201.386ns
Interaction (K.V)	6	109.913ns	106.398ns	333.259ns	464.828ns	4.226ns	235.015ns
Error	22	133.858	108.989	152.202	312.014	4.126	448.227
CV%	21.014	14.831	15.288	18.895	21.465	31.516	

NS, * = non-significant and significant probability level at 5%, respectively.

Table 4
Mean comparison of sesame height

Treatments	*Means of height*					
	30 DAP	*45 DAP*	*60 DAP*	*75 DAP*	*90 DAP*	*105 DAP*
K1(Potassium sulfate)	14.597b	56.641	75.444	86.000	103.139	114.000
K2(*Bacillus circulans* L.)	16.907ab	30.42	66.444	76.889	80.031	80.406
K3(*Bacillus megatherium* L.)	20.298a	45.322	68.000	77.667	82.499	85.013
K4 (B. *circulans*+ *B. megatherium*)	14.234b	52.836	71.667	82.222	98.252	99.287
V1)Ultan)	16.868	53.923	67.667	78.917	81.613	89.474
V2 (Yekta)	15.344	53.84	73.417	74.917	78.906	89.608
V3 (Dashtestan 2)	17.314	57.402	70.083	72.25	72.922	82.447
K1V1	14.980	54.473	72.000	85.67	103.62	76.44
K1V2	16.477	59.117	82.333	88.33	112.90	76.03
K1V3	12.333	56.333	72.000	84.00	92.90	69.53
K2V1	16.667	56.763	65.333	77.67	84.09	74.69
K2V2	17.440	49.063	63.000	68.33	84.68	61.03
K2V3	16.613	60.433	71.000	84.67	101.32	69.50
K3V1	22.457	48.453	59.667	69.67	91.63	61.26
K3V2	15.460	52.847	72.000	97.67	111.71	81.56
K3V3	22.977	64.667	72.333	65.67	74.16	52.22
K4V1	13.370	56.000	73.667	82.67	87.12	65.51
K4V2	12.000	54.333	76.333	85.33	86.33	59.82
K4V3	17.333	48.173	65.000	78.67	91.31	58.53

measurements in 6 times with 15 days interval. Similar results were obtained by Mekki et al. (5) and Kalaiselvan et al. (4).

The results showed that in all three sesame cultivars the height of plant was not affected by cultivars properties at all. The same results were found in number of branches and capsules per plant too.

But, thousand seed weight, seed yield and oil content in sesame seeds were significantly affected in cultivars (table 6).the most seed weight in 1000 seed weight scale was observed in Yekta cultivar by 3.7 g and also the seed yield in this cultivar by 18.62 gram seed production in each plant was maximum but in case of oil percentage in seeds the Ultan cultivar had the highest oil content by 46.08%

Table 5
Effect of K on sesame number of branches and capsule /plant, seed weight and seed yield and oil content

		MS				
sov	*df*	*branches/plant*	*capsules/plant*	*1000-seed weight*	*seed yield*	*oil content*
Replication	2	956.871	178.062	0.034	2.770	23.152
Potassium (K)	3	357.481ns	262.320ns	0.037ns	12.983ns	5.371ns
Cultivars (V)	2	38.384ns	201.386ns	0.362**	143.316**	93.013**
Interaction (K.V)	6	235.933ns	235.015ns	0.049ns	1.683ns	4.676ns
Error	22	563.826	448.227	0.064	13.530	2.879
CV%	26.81	31.516	7.16	24.15	3.96	

NS, * = non-significant and significant probability level at 5%, respectively.

Table 6
Mean comparison of sesame number of branches and capsule /plant, seed weight and seed yield and oil content

	Means				
Treatments	*branches/ plant*	*capsules/ plant*	*1000-seed weight (g)*	*seed yield g/plant*	*oil content %*
K1(Potassium sulfate)	5.563	86.27	3.567	15.35	43.511
K2(*Bacillus circulans* L.)	4.185	97.21	3.444	16.79	42.633
K3(*Bacillus megatherium* L.)	5.341	88.54	3.489	13.94	41.900
K4 (B. *circulans*+ *B. megatherium*)	4.505	82.31	3.578	14.80	43.489
V1)Ultan)	4.505	86.738	3.483ab	15.35b	46.083a
V2 (Yekta)	5.398	88.693	3.708a	18.62a	41.550b
V3 (Dashtestan 2)	4.793	90.310	3.367b	11.70c	41.017b
K1V1	5.180	77.76	3.500	15.34	47.500
K1V2	5.873	84.89	3.700	19.45	40.700
K1V3	5.637	96.16	3.500	11.26	42.333
K2V1	2.793	105.08	3.300	17.13	45.867
K2V2	5.103	96.26	3.800	19.33	42.833
K2V3	4.660	90.28	3.233	13.92	39.200
K3V1	5.597	88.93	3.433	13.61	45.000
K3V2	6.873	93.92	3.700	18.07	40.133
K3V3	3.553	82.77	3.333	10.14	40.567
K4V1	4.450	75.19	3.700	15.30	45.967
K4V2	3.743	79.70	3.633	17.62	42.533
K4V3	5.323	92.03	3.400	11.47	41.967

as a high oil cultivar (table 6). Similar results were obtained by Mekki et al. (5) and Kalaiselvan et al. (4).

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