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EFFECT OF POTASSIUM AND SULPHUR ON YIELD, QUALITY AND NUTRIENT UPTAKE OF WINTER SEASON BERSEEM (*Trifolium alexandrinum* L.) IN CENTRAL PART OF INDIA

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ABSTRACT

A pot experiment was carried out with the aim to quantify the effect of potassium and sulphur on yield and composition of berseem (*Trifolium alexandrinm* L.) during the winter season of 2014-2015, at the Agriculture experimental field, Nehru P.G. College Lalitpur (U P). The treatments consisted of four potassium levels (0, 30, 60 and 90 kg ha^{-1}) and four sulphur levels (0, 10, 20 and 40 kg S ha^{-1}). The experiment was laid out in RBD with three replications. Application of 90 kg K_2O ha^{-1}with 20 kg S ha^{-1} significantly increased the protein content of berseem. The maximum N, P, K and S nutrient uptakes in berseem plants were recorded with 90 kg K_2O and 40 kg S ha^{-1}.

(Keywords: Potassium,sulphur, protein content, nutrient uptake and berseem)

INTRODUCTION

Shortage of green fodder is a common problem throughout the country. Among major fodder crops, Berseem (*Trifolium alexandrinum* L.) is one of the most important leguminous fodder crops of subtropical countries. This fodder crop is mainly grown in the northern part of India in *rabi* season. It is most productive and nutritious fodder crop (Khinchi *et al.,* 2017). Berseem plant is most valuable forages available for stock feeding (Kumawat and Khinchi, 2017). The protein percentage of berseem clover has been reported as much as 20.96% (Ansari and Ghadimi, 2015). More than 75 per cent of the population either directly or indirectly depends on agriculture (Singh and Wanjari, 2012). It is rich in protein and other total digestible nutrients, as well as carotenes and minerals; it is very nutritious, succulent, palatable and high yielding valuable leguminous crop (Mohbe *et al.,* 2015 and Dharwe *et al.,* 2019). The nutrient element of major significance for yield and quantity of berseem are nitrogen, phosphorus and sulphur (Gaedi *et al.,* 2018 and Malvi *et al.,* 2019). Fodder and nutritional security for the livestock population plays a vital and catalytic role in the Indian farming system. Optimum nutrition is required for getting maximum production of fodder of good quality. Several abiotic and biotic factors have been found to affect the yield of berseem. Apart from major plant nutrients, potassium and sulphur play an important role in the production phrenology of legume crops and these crops respond well to applied K and S (Dotaniya *et al.,*2014; Singh, 2018 and Khandagle *et al*., 2019).

Potassium is one of the essential primary nutrients for fostering crop production, while the importance of balanced fertilizer use is widely and forced fully recognized its actual practice over much of the agriculture area (Dotaniya *et al.,* 2019 and Dotaniya *et al.,* 2020b). Potassium (K) is extremely important for the growth of the plant root system. Potassium improves the root development, especially in legumes and pulses (Dotaniya *et al.,* 2016 and Dotaniya *et al.,* 2020c.). Sulphur plays an important role in chlorophyll formation because it has been observed that sulphur deficient plants contain as 40 to 60% in comparison with those receiving normal amounts of these elements (Mohbe *et al.,* 2018a, Mohbe *et al.,* 2018 and Dotaniya *et al.,* 2020a). However, studies investigating the impact of

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potassium and sulphur application on yield of berseem remain scarce.Therefore, the present investigation was planned to study the effect of potassium and sulphur on yield and quality of winter season berseem in central part of India.

MATERIALS AND METHODS

The pot experiment was carried out at agriculture experimental field, Nehru P.G. College, Lalitpur (Bundelkhand University), Uttar Pradesh during *rabi* season of 2014-2015. Lalitpur district is a part of Bundelkhand plateau. Betwa River is the boundary between Jhansi and Lalitpur in the north. Most of the area is below the average elevation of 300m–450m from the sea level. Its latitudinal extension is from 24^0 10' to 25^0 15' N and longitudinal extension is from 78^0 10' E to 79^0 00' E. Geographically, Lalitpur district falls in the zone of sub-tropical climate and may be characterized by a very hot dry summer and cold winter. The soil of the experimental pot was loam in texture with sand (28.6%), silt (40.8%) and clay (55.2%)having pH 7.9, organic carbon 4.6 g kg^{-1} and available N, P, K and Sulphur 84.67, 5.13, 96.45 and 8.78 kg ha^{-1}, respectively. The experiment was laid out in randomized block design with three replications. The treatments were four levels each of the K (0, 30, 60 and 90 kg K_2O ha^{-1}) and S (0, 10, 20 and 40 kg S ha^{-1}). Diammonium phosphate as a source of P and potassium dichromate as a source of K were used. Sulphur was applied as elemental sulphur at the time of sowing (Kumar *et al.,* 2018). Berseem was sown in the last week of November, 2014. The crop was grown by adopting all agronomic practices except fertilizer rate. The crop was harvested at various stages of growth and data converted into kg ha^{-1}.

The turbid metric method outlined by Chesnin and Yien (1951) was followed in the determination of sulphur in the extract of plants obtained after digestion with nitric and per-chloric acid (Johnson and Ulrich, 1959).Seed nitrogen content was estimated by kjeldhal's method and nitrogen content was multiplied with factor 6.25 to get the seed protein content.(Jackson,1973). Phosphorus content was estimated by ammonium vando-molybdate yellow colour method as described by Chapman and Pratt (1961). Potassium was estimated by flame photometer (Jackson,1973). The chemical character like pH (Kumar *et al.,* 2018), EC (Richards, 1954), Organic carbon (Walkley and Black,1934),CEC by Sodium acetate (Richards, 1954), Bulk density (Black, 1965), uptake and protein yield were calculated by following formula.

$$\textbf{Protein yield (kg ha}^{-1}\textbf{)} = \frac{\text{Protein content (\%) X Seed yield (kg ha}^{-1})}{100}$$

Nutrient Uptake(kg ha^{-1})

$$= \frac{\text{Nutrient content in seed (\%) X Seed yield kg-1+ Nutrient content in straw (\%) X Straw yield kg-1}}{100}$$

RESULTS AND DISCUSSION

Yield studies

The data in Table 1 reveals that the green foliage yield of berseem significantly increased with potassium application. The increases in the yield at each level of potassium addition were found to be significant as compared to control. The maximum yields of green forage were recorded under 90 kg K_2O ha^{-1}. All the levels of K differed significantly among themselves in respect of green forage production of berseem. Similarly, Singh (2018) also reported that application of 60 kg K_2O ha^{-1} increased mean yield of green foliage of oat by 46.0 and 30.3 % respectively, over control.

Application of sulphur enhanced the green forage yield of berseem significantly over control. All the levels of S proved significantly superior over control in respect of green forage production. The maximum green forage production was noted under 40 kg S ha^{-1}. The green forage yield of berseem increased by 7.1, 9.9 and 10.0 % with 10, 20 and 40 kg S ha^{-1} levels over control respectively. The corresponding increases in green forage production were 9.0, 10.9 and 8.6 %. The higher level of sulphur 40 kg S ha^{-1} tended to decrease the green forage yield in berseem over 20 kg S ha^{-1}. Similarly, Singh and Singh (2017) also found that application of 40 kg S ha^{-1} as elemental S resulted in 26.6 and 24.2% increase in grain and straw yield of green gram over control, respectively. The highest grain yield (10.90 q ha^{-1}) was obtained with 40 kg S ha^{-1} as gypsum and resulted in 30.2% increase over control. The increases in straw yield due to 40 kg S ha^{-1} as elemental S and gypsum were 24.2 and 27.3% over control, respectively.The interaction effect of potassium and sulphur on green forage production was significant. The maximum green forage yields were recorded at 60 kg K_2O and 40 kg S ha^{-1} treatment. Mohbe *et al.* (2018) resulted maximum seed yield of 9.31 g $plant^{-1}$.However, the maximum seed yield $plot^{-1}$ 1368 g were recorded with the application of poultry draige @ 3 ton ha^{-1}.

Qualitative studies

Further, an examination of data in Table1 reveals that the application of potassium increased the protein content in berseem and this effect was significant with each level of potassium. All the levels of potassium increased the protein content in berseem significantly over control. The lowest average value of protein content was recorded in control treatment. The protein content increased from 2.13, 4.54 and 9.52 % in berseem with 90 kg ha^{-1} K_2O addition. However, this reducing in protein content was statistically significant. Sood and Kumar (1998) also concluded that the application of P_20_5 at 30 to 90 kg ha^{-1} increased the fresh forage yield.

Sulphur application has a significant effect on the protein content in berseem crop. S application caused a significant enhancement in protein content. The per cent increase were 9.25, 17.13 and 21.49 due to 10.20 and 40 kg S ha^{-1}. All the higher doses of sulphur application were found significantly superior over control. These findings are similar to those of Malvi *et al.* (2019). They also recorded the maximum green forage production under 40 kg S ha^{-1}. The green forage yield of berseem increased by 7.1, 9.9 and 10.0 % with 10, 20 and 40 kg S ha^{-1} levels over control respectively.The Interaction (K×S) effect on nitrogen content was found to be significant.Dharwe *et al.,* (2018) reported that highest protein yield in seed was found with 40 kg S ha^{-1} and 90 kg P_2O_5 ha^{-1}. Singh (2018) reported that increasing levels of K significantly increased the protein content in oat plants from 10.5 % at control to 11.3 % at 80 kg K_2O ha^{-1}.

Nutrient uptake studies

Nitrogen uptake

Data pertaining to nitrogen uptake by berseem forage are summarized in Table 2 and Fig. 1 reveals that the lower levels of potassium applied in the present investigation were found to be significantly different from each other in respect of nitrogen uptake by berseem. The enhanced values of N uptake by berseem is due to application of 30, 60 and 90 kg K_2O ha^{-1}. However, the higher values of K (60 and 90 kg K_2O ha^{-1}) were statistically on par in respect of nitrogen uptake by berseem.A further study reveals that the application of S increased the nitrogen uptake by berseem crop significantly. The sulphur levels *i.e.* 10, 20 and 40 kg S ha^{-1} resulted 19.06, 29.87 and 40.02 per cent enhancement in the nitrogen uptake by berseem respectively over control.

All the levels of sulphur proved significantly superior over control in respect of N uptake by berseem. The nitrogen uptake by crop due to the addition of potassium and sulphur enhanced significantly in the presence and absence of each other. The higher value of N uptake by crop were noted under 40 kg ha^{-1} S and 90 kg ha^{-1} K_2O. Sood (1998) also reported that application of 40 kg S and 90 kg P_2O_5 ha^{-1} recorded more uptake in berseem and oat.'The interaction effect was non-significant. Similarly, the maximum concentrations of N in berseem plant were recorded at 40 kg S ha^{-1} by Malvi *et al.* (2019). Per cent enhancement were 6.74, 15.92 and 19.48 in seed and 31.60, 54.50 and 69.71 in straw of green gram due to 10, 20 and 40 kg S ha^{-1} over control respectively(Dharwe *et al.*, 2019a). Bairwa *et al.* (2020) found increase in N uptake with the application of sulphur @ 40 kg ha^{-1} in onion.

Phosphorus uptake

The data pertaining to the phosphorus uptake by berseem as affected by different treatment are presented in Table 2 and Fig 1. A perusal of the data given in Table 2 indicates that the application of potassium increased the P uptake by berseem due to 30, 60 and 90 kg ha^{-1} K_2O over control were 33.38, 43.38 and 52.51 per cent, respectively. All the levels of K tried in the present investigation were found highly significant with each other in respect of P uptake by berseem crop.

A perusal of the data given in Table 5 obviously elucidates a highly significant effect of the sulphur levels on the uptake of phosphorus by berseem crop. The increased values of P uptake by berseem due 10, 20 and 40 kg ha^{-1} S were 21.41, 37.90 and 50.58 per cent over control respectively. Phosphorus (P), as an essential plant nutrient for crop production, acts as energy currency in plant, cell elongation, respiration, promotes root growth, early plant maturity and stalk strength, and imparts resistance to stress conditions. Apart from its importance in crop production, it is also a costly input across the globe (Dotaniya *et al.*, 2014 and Dotaniya *et al.*, 2020). The interaction effect of (K×S) on phosphorus uptake was found to be significantly. Similarly, Malvi *et al.* (2019) also recorded that content of P in berseem plants increased with the increasing levels of K and maximum value was recorded with the application of 60 kg K_2O ha^{-1}. Dharwe *et al.* (2019) reported that content of P in green gram plants increased with the increasing levels of K and maximum value was recorded with the 40 kg S ha^{-1}.

Potassium uptake

A study of the Table 3 and Fig. 1 reveals that the K uptake by berseem crop significantly increased with its application. There was a consistent and significant increase in K uptake values were recorded at 90 kg ha^{-1} K_2O. The increased uptake of potassium due to 30, 60 and 90 kg ha^{-1} K_2O application by berseem was greater by 37.78, 60.40 and 73.41 kg ha^{-1} over control, respectively. All the levels of K application tried in this investigation differed significantly from one another in respect of potassium uptake by berseem crop. These findings are similar to those of Malvi *et al.* (2019) which recorded the maximum concentration of K in berseem under application of 90 kg K_2O ha^{-1}.

The application of sulphur to the soil proved beneficial for the uptake of K by berseem. All the levels of S proved significantly superior over control and also differed significantly from one another in respect of potassium uptake by berseem. The maximum values of uptake by berseem were recorded at 40 kg ha^{-1} S. The uptake of K by berseem increased from 14.25, 20.54 and 26.87 kg ha^{-1}, respectively with 40 kg ha^{-1} S. These findings are similar to those of (Dotaniya *et al.* 2016a. Bairwa *et al.*(2020) applied fertilizer @ 80 kg K ha^{-1} (soil application) + 20 kg K ha^{-1} (4 foliar sprays) and found significant increase in N, P, K and S uptake by the onion bulb.The interaction (K×S) effect of the utilization of K by berseem crop was significant. Bairwa *et al.* (2020) studied the combined effect of different nitrogen and potassium fertilization and found significant influenced on N uptake by onion bulb by the application of 60 kg N ha^{-1} (soil application) + 20 kg N ha^{-1} (4 foliar sprays) and 60 kg K ha^{-1} (soil application) + 20 kg K ha^{-1} (4 foliar sprays). The K uptake by oat crop increased from 95.7 to 141.9 kg ha^{-1} as the dose of K was increased from 0 to 60 kg K_2O ha^{-1} (Singh *et al.,* 2016).

Sulphur uptake

The data related to S uptake by berseem as affected by the addition of K were found to be significant over control and these different levels of K also differed significantly with each other in regard of S uptake by berseem crop. The enhancement in the value of S uptake by berseem due to 30, 60 and 90 kg ha^{-1} K_2O was 30.91, 43.12 and 46.85 per cent over control respectively.

A further study of the data from Table 3 and Fig. 1 obviously elucidate all the levels of sulphur were significantly superior over control with regards to S uptake by berseem crop. Different levels of sulphur were significantly superior with each other in respect of sulphur uptake by berseem. The value of sulphur uptake by berseem increased from 23.90, 34.82 and 50.98 kg ha^{-1} with 40 kg ha^{-1} S level, respectively. The maximum values of S uptake by berseem were recorded with 40 kg ha^{-1} S. Salame *et al.* (2020) recorded the maximum values of sulphur uptake by sesame under rainfed condition with application of 60 kg P_2O_5 + 45 kg sulphur ha^{-1}. The interaction (K×S) was found significant .

It may be concluded from the results that light textured soils were deficient in K and S. Application of 60 kg K_2O and 20 kg S ha^{-1} was found optimum for maintaining potassium and sulphur nutrient content in soils of Lalitpur district of Uttar Pradesh, which produced optimum yield of berseem crop with higher seed protein content and nitrogen, phosphorus, potassium and sulphur uptakes.

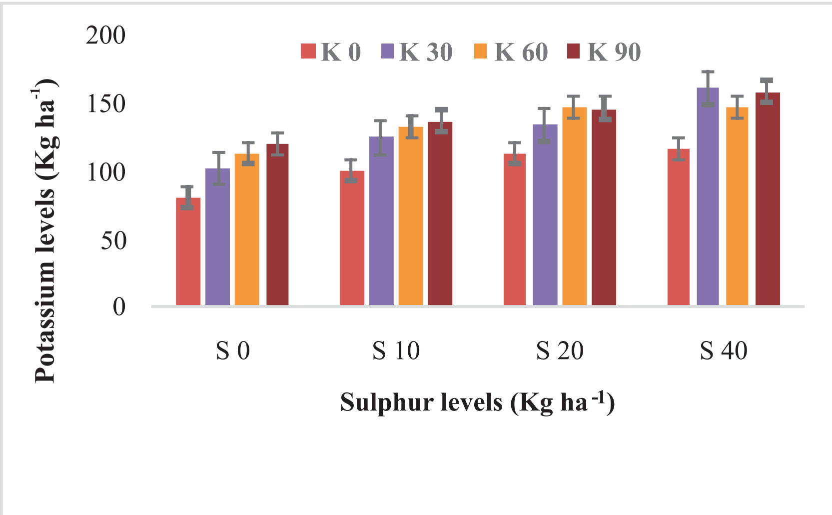
Table 1.Effect of K and S level on green forage yield and protein content of berseem

Potassium levels (Kg ha^{-1})	Green Forage yield (total of five cuttings)					Protein content (%)				
	Sulphur Levels (kg ha^{-1})									
	S_0	S_{10}	S_{20}	S_{40}	Mean	S_0	S_{10}	S_{20}	S_{40}	Mean
K_0	350.42	394.29	421.71	412.37	394.69	12.56	13.74	14.74	15.24	14.07
K_{30}	425.65	461.90	548.74	473.35	477.41	12.75	13.87	15.30	15.56	14.37
K_{60}	469.28	493.91	521.28	502.74	496.80	13.12	14.49	15.24	16.01	14.71
K_{90}	487.28	506.97	519.97	516.62	507.61	13.87	15.05	15.99	16.74	15.41
Mean	433.15	464.26	502.82	476.27		13.07	14.28	15.31	15.88	
	K	S	K×S			K	S	K×S		
SE (d)±	17.22	17.22	34.44			0.21	0.21	0.43		
CD at %	35.16	35.16	70.33			0.44	0.44	0.88		

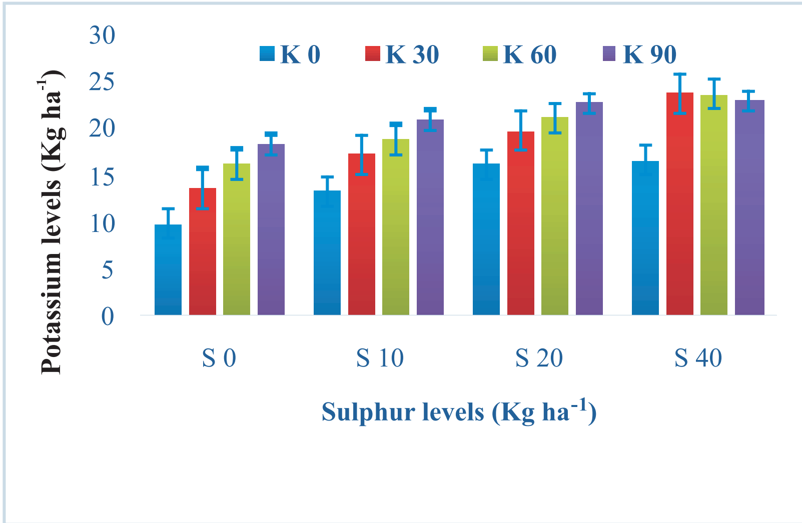
Table 2. Effect of K and S levels on nitrogen and phosphorus uptake of berseem

Potassium levels (Kg ha^{-1})	Nitrogen uptake (Mg pot^{-1})					Phosporus uptake (Mg pot^{-1})				
	Sulphur Levels (kg ha^{-1})									
	S_0	S_{10}	S_{20}	S_{40}	Mean	S_0	S_{10}	S_{20}	S_{40}	Mean
K_0	80.82	100.54	113.28	115.89	102.63	9.71	13.23	16.10	16.58	13.90
K_{30}	101.62	124.34	133.71	160.81	130.12	13.54	17.16	19.73	23.73	18.54
K_{60}	112.99	132.53	146.19	146.19	134.57	16.18	18.81	21.08	23.67	19.93
K_{90}	119.64	136.76	145.87	158.29	140.14	18.29	20.90	22.70	22.94	21.20
Mean	103.76	123.54	134.76	145.29		14.43	17.52	19.90	21.73	
	K	S	K×S			K	S	K×S		
SE (d) ±	13.13	13.13	26.27			0.62	0.62	1.24		
CD at %	26.82	26.82	-			1.26	1.26	2.53		

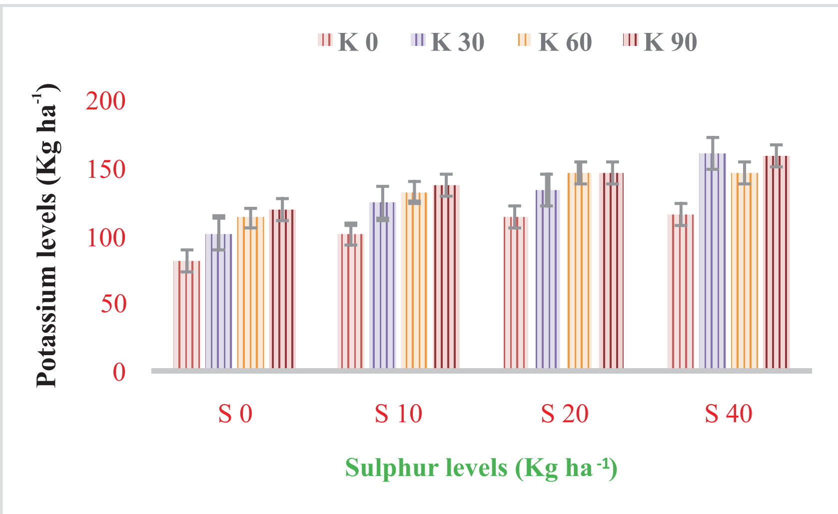
Nitrogen uptake (mg pot^{-1})



Phosphorus uptake (mg pot^{-1})



Potassium uptake (mg pot^{-1})



Sulphur uptake (mg pot^{-1})

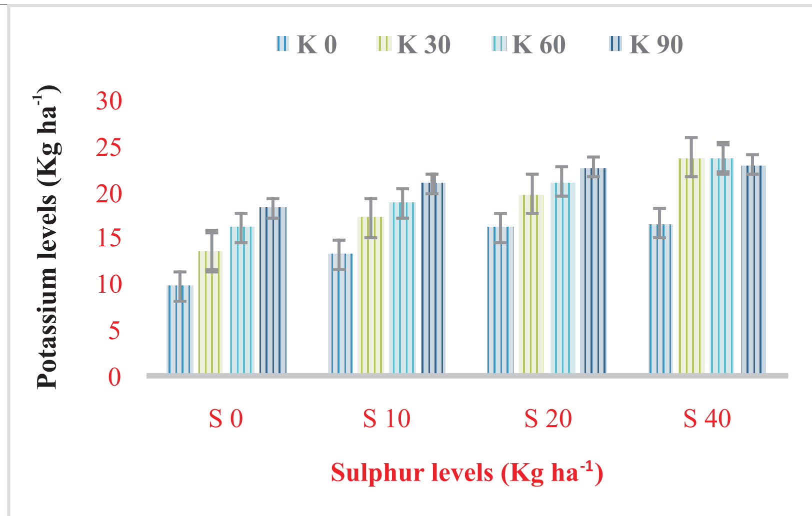


Table 3. Effect of K and S levels on potassium and sulphur uptake of berseem

Potassium levels ($Kg\ ha^{-1}$)	Potassium uptake ($mg\ pot^{-1}$)					Sulphur uptake ($mg\ pot^{-1}$)				
	S_0	S_{10}	S_{20}	S_{40}	Mean	S_0	S_{10}	S_{20}	S_{40}	Mean
K_0	42.52	50.53	54.78	55.47	50.82	7.32	10.45	11.86	12.29	10.48
K_{30}	58.06	67.46	71.72	82.86	70.02	10.15	12.87	14.22	17.67	13.72
K_{60}	72.44	80.70	84.33	88.62	81.52	12.10	14.85	15.39	17.66	15.22
K_{90}	78.67	88.90	92.59	92.39	88.13	13.27	14.91	16.31	17.07	15.39
Mean	62.92	71.89	75.85	79.83		10.71	13.27	14.44	16.17	
	K	S	K×S			K	S	K×S		
SE (d) ±	2.39	2.39	4.79			0.64	0.64	1.28		
CD at %	4.89	4.89	9.79			1.31	1.31	2.62		

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