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Influence of potassium and sulphur nutrition on quality of garlic (*Allium sativum* L.)

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Abstract

The field experiment was conducted at the Vegetable Research Farm and Biochemistry laboratory, PAU, Ludhiana during Rabi seasons of 2020-21 and 2021-22 to study the effect of potassium and sulphur on the quality of garlic. The experiment comprised of sixteen treatment combinations with four levels each of potassium (0, 20, 40 and 60 kg K /ha) and sulphur (0, 10, 20 and 30 kg S/ha). It was laid in a randomized complete block design and replicated thrice. Variety 'PG-18' was used as plant material. Potassium and sulphur were applied as basal dose at bed preparation. The results depicted that quality parameters were influenced by with these nutrients. Maximum allicin (12.19 and 12.64 mg/g), TSS (41.3 and 41.5%), ascorbic acid (21.64 mg/100 g dry weight and 21.81 mg/100 g dry weight) and total minerals (53.17 mg/100g dry weight and 53.56 mg/100g dry weight), dry matter (42.40 and 42.97%), total protein (120.8 and 112.1 mg/g) were recorded with application of 60 kg/ ha potassium and 30 kg/ ha of sulphur respectively. Maximum phenols (0.54 mg/g) and total sugars (182.2 mg/g) was recorded under the interaction of 60 kg/ ha potassium and 30 kg/ ha of sulphur.

Keywords: Sulphur, Potassium, Garlic, Allicin, TSS, Total Minerals

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Introduction

Garlic *(Allium sativum* L.) is the world's second most important bulb crop after onion (Purseglove 1985). Garlic has spread worldwide and is being used in the kitchen of every household as spice and seasoning purposes (Gupta *et al.* 2021). Garlic cloves are a good source of nutrients and phytochemicals for boosting immunity. The edible portion of garlic is composed of 62.8% moisture, 6.3% protein, 29% carbohydrates, 13 mg/100 g vitamin C, 0.03% calcium, 0.31% phosphorus, 0.0031% iron and pyruvic acid content of 35 to 60 micromoles/ g (Magray *et al.* 2017). Its medicinal value has been well recognized in treating and controlling hypertension, worms, rheumatism, germs, bacteria, fungal diseases, diabetes, ulcer and cancer (Kilgori *et al.* 2007; Samavatean *et al.* 2011). Garlic can be consumed in various forms, including raw, oil, extracts, and powder with different benefits (Lanzotti *et al.* 2014). Garlic is cultivated in China, India, Bangladesh, South Korea, Egypt, Spain, USA, Algeria, Uzbekistan, and Ukraine, of which China alone contributes 75.7% of the total production, followed by India contributing 9.5%, while other countries contribute only 14.8% (Anonymous 2021). Garlic covers an area of 349.39 thousand ha, producing 2923.15 thousand tonnes in India (Anonymous 2021). The productivity of garlic depends upon cultural practices followed during the cultivation, out of which nutrient management have a crucial role. For producing one ton of garlic bulbs, crop removes 9.49 kg of N, 1.21 kg of P and 3.8 kg of K and 0.9 kg of S (Thangasamy

et al. 2018). Garlic crop takes about around 185 days from sowing to harvesting. Therefore, getting the best yields from a crop consuming half a year of cropping time is important.

Garlic is very sensitive to deficiency of nutrients because of shallow root system. In earlier times, the farmers were more dependent on use of farm Yard Manures before the advent of HYVs and inorganic fertilizers, which prevented the deficiencies of many macro and microelements. But in recent years, the nutrients have been depleted from soils due to exhaustive cropping cycles and reduced applications of organic manures and composts. The optimum amount of nutrients required for garlic production depends on soil conditions, climatic factors, irrigation systems and crop management systems. The lack of proper management of nutrients will adversely affect the yield and quality of the crop as it is required for the synthesis of various proteins, vitamins, and co-enzymes. Thus, there is a need to develop a nutrient management strategy for garlic based on regions that will improve nutrient use efficiency and yield and quality of the produce. Among nutrients, potassium is regarded as a primary macronutrient and is consumed in hefty amounts by plants. It plays an important role in the movement of water, nutrients and carbohydrates with in plant tissue. Potassium is said to increase the post-harvest life as well as improve color, glossiness and dry matter content (Dorais *et al.* 2001). It increases resistance against insects and diseases in plants and has an important role in the metabolism of plant and is therefore named as 'quality element' and the overall yield and quality of the plant (Magray *et al.* 2017).

Sulphur, a secondary macro-nutrient, is also consumed in high amounts right after nitrogen, phosphorus and potassium. Bulb crops, including garlic, are sulphur-loving crops with high requirements for proper growth and yield. It is a very important nutrient for the synthesis of major sulphur containing amino acids (cystine, methionine and cysteine) and is involved in many metabolic activities in plants (Magray *et al.* 2017). Apart from primary macronutrients (N, P and K) fertilizers, use of sulphur fertilizers can significantly improve the yield in garlic (Ahmed *et al.* 1988), as sulphur is beneficial for nitrogen uptake by plant and hence improves the yield. Sulphur deficiency during bulb development can cause serious reduction in the allicin and other sulphur-containing proteins (Chattoo *et al.* 2019). A long term of cultivation of crops has led to sulphur deficiencies due to uptake and is becoming a majorly deficient nutrient worldwide (Aulakh *et al.* 2003). Sulphur deficiency in Indian soils has become more widespread also due to use of sulphur free fertilizers (Chattoo *et al.* 2019). With increasing population pressure and limited land for food production, there is a need to produce more quality food by improving cultural practices including adequate and balanced crop fertilization. Much research hasn't been conducted on the garlic crop regarding potassium and sulphur application. The research will be novel and beneficial for the growers of region with regards to increasing the quality and overall income. So, the proposed investigation was undertaken to study the effect of potassium and sulphur on the quality of garlic.

Materials and Methods

The present investigation was conducted at the Research Farm of Vegetable science and Biochemistry Laboratory PAU, Ludhiana, during rabi seasons of 2020-21 and 2021-22. The soil of the experimental plot was loamy sand in texture, having a pH 7.6, available NPK and S 140:32:62.5:13 kg/ha, respectively. The experiment comprised of sixteen treatment combinations with four levels of potassium (0, 20, 40 and 60 kg K/ha) and sulphur (0, 10, 20 and 30 kg S/ha). It was laid in a randomized complete block design and replicated thrice. Variety 'PG-18' was used as plant material. Potassium and sulphur were applied as basal dose at bed preparation. The recommended dosages of nitrogen @100 kg /ha and phosphorus @50 kg /ha were applied. The full dose of phosphorus was applied at the time of sowing as basal dose, whereas nitrogen was applied in three equal doses, after 30, 45 and 60 days of sowing. Rest of the agronomic practices was followed in accordance with the package of practice. Quality parameters like allicin (mg/g), TSS (%), ascorbic acid (mg/100g dry weight) and total minerals (mg/100g dry weight), dry matter (%), total protein (mg/ g), phenols (mg/g), total sugars (mg/g) and reducing sugars (mg/g) were recorded. Recorded data was statistically analyzed according to the procedure outlined by using CPCS1 software (Steel and Torrie 1981). A comparison of the mean values of different treatments was made at 5% level of significance.

Results and Discussion

Ascorbic acid

It is an important quality aspect of garlic. Ascorbic acid helps build up immunity in humans and is considered an important supplement. The data pertaining to the ascorbic acid affected by potassium and sulphur is shown in Table 1. Pooled data of both seasons showed maximum ascorbic acid using 30 kg/ha S (21.8 mg/100 g dry weight), significantly higher than the rest of treatments. Use of 60 kg/ha K showed the greatest mean ascorbic acid (21.6 mg/100g dry weight) among potassium treatments, significantly different from all other treatments. During 2020-21, highest ascorbic acid was obtained by using 30 kg/ha S (21.9 mg/100g dry weight) followed by 20 kg/ha (20.7 mg/100g dry weight), significantly higher than all treatments. Use of K @60 kg/ha (21.5 mg/100g dry weight) gave highest ascorbic acid followed by K 40 kg/ha (20.3 mg/100 g dry weight) being significantly different from all treatments. During 2021-22, 60 kg/ha K (21.7 mg/100 g dry weight) followed by 40 kg/ha (20.4 mg/100 g dry weight) gave the highest ascorbic acid, significantly different from all treatments. The use of S 30 kg/ha (21.7 mg/100g dry weight) gave highest ascorbic acid

Table 1: Influence of different levels of potassium and sulphur applications on Ascorbic acid, Total minerals, Dry matter and TSS (%)

Treatments	*Ascorbic acid (mg per 100g dry weight)*			*Total minerals (mg per 100g dry weight)*			*Dry matter (%)*			*TSS (%)*		
	2020-21	*2021-22*	*Pooled data*	*2020-21*	*2021-22*	*Pooled data*	*2020-21*	*2021-22*	*Pooled data*	*2020-21*	*2021-22*	*Pooled data*
K_0	19.8	19.9	19.87	51.2	50.9	51.07	39.7	39.3	39.51	39.7	39.9	39.8
K_{20}	19.5	19.2	19.36	51.4	51.9	51.67	40.4	40.9	40.70	40.3	40.3	40.3
K_{40}	20.3	20.4	20.37	52.2	52.4	52.31	41.6	42.4	42.02	40.5	40.7	40.6
K_{60}	21.5	21.7	21.64	53.1	53.2	53.17	42.5	42.3	42.40	41.2	41.5	41.3
LSD (p<0.05) K	0.8	0.8	0.55	1.1	1.2	0.78	1.6	1.1	0.95	0.5	0.8	0.45
S_0	18.6	18.4	18.50	50.4	50.1	50.24	38.9	39.5	39.23	39.3	39.6	39.4
S_{10}	20.0	20.4	20.24	51.8	52.2	51.98	40.4	41.1	40.77	40.4	40.2	40.3
S_{20}	20.7	20.7	20.69	52.3	52.5	52.45	41.3	42.0	41.65	40.5	41.0	40.7
S_{30}	21.9	21.7	21.81	53.4	53.6	53.56	43.5	42.4	42.97	41.4	41.5	41.5
LSD (p<0.05) S	0.7	0.8	0.53	1.0	1.1	0.79	1.5	1.0	0.93	0.4	0.7	0.44
LSD (p<0.05) K×S	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

followed by S 20 Kg/ha (20.7 mg/100g dry weight) among the sulphur treatments being at par statistically among each other but higher significantly compared to other treatments. Results found were in conformity with Divyasree *et al.* (2021) who used potassium sulphate @ 60 Kg/hato get maximum ascorbic acid (20.81 mg/100g dry weight). Arisha et al. (2017) used 125 kg K2O/ fed to get maximum ascorbic acid (25 mg/100g dry weight) in another experiment.

Total minerals

The total mineral present in a crop gives us an idea about the concentration of various nutrients. The data regarding to the total minerals affected by potassium and sulphur is shown in Table 1. It has been observed from pool data of both seasons that maximum total minerals were in that treatment where 30 kg/ha S (53.5 mg/100g dry weight) was applied, which was significantly higher than the rest of the treatments. Using 60 kg/ ha K showed the greatest mean total minerals (53.1 mg/100g of dry weight) among potassium treatments, significantly different from all other treatments. During 2020-21, the highest total minerals were obtained using 30 kg/ha S (53.4 mg/100g dry weight) followed by 20 kg/ ha (52.3 mg/100g dry weight), significantly higher than all treatments. Use of K 60 kg/ha (53.1 mg/100g dry weight) gave the highest total minerals, followed by K 40 kg/ha (52.2 mg/100g dry weight) being at par statistically with each other but significantly different in comparison to other treatments. During 2021-22, S 30 kg/ha (53.6 mg/ 100g dry weight) gave the highest total minerals followed by S @ 20 kg/ha (52.5 mg/100g dry weight) among the sulphur treatments being at par statistically with each other but different significantly in comparison to other treatments. The use of 60 kg K per ha (53.2 mg/100g dry weight) followed by 40 kg/ha (52.4 mg/100g dry weight) gave the highest total minerals among potassium treatments being at par statistically with each other but different significantly in comparison to other treatments.

Dry matter

The data regarding dry matter influenced by various doses of potassium and sulphur is shown in Table 1. Pooled data of both seasons showed maximum dry matter content with 30 kg/ha S (42.9%) which was significantly higher than rest. Using 60 kg/ha S gave highest mean dry matter content (42.4%) followed by 40 Kg/haK (42.0%) being at par statistically among each other but different significantly compared to other treatments. During 2020-21, the highest dry matter content was obtained by using 30 kg/ha S (43.5%) followed by 20 kg/ha (41.3%), which was significantly higher than all treatments. The use of K 60 kg/ha (42.5%) gave highest dry matter content followed by K was applied at the rate of 40 kg/ha (41.6%), being at par statistically among each other but different significantly compared to other treatments. In season 2021-22, S 30 kg/ha (42.4%) gave highest dry matter content followed by S 20 kg/ha (42.0%) among the sulphur treatments being at par statistically among each other but different significantly compared to other treatments. Use of 40 kg/ha (42.4%) followed by 60 kg K ha^{-1} (42.3%) gave the highest dry matter content among potassium treatments being at par statistically among each other but significantly different compared to other treatments. The results found were in conformity with Bloem *et al.* (2010) who got maximum dry matter of 31.1% by using 45 kg/ha S. In another experiment, Diriba-Sheferaw *et al.* (2014) observed highest (39.76%) dry matter by using 60 kg/ha S.

Total soluble solids *(*TSS)

The total soluble solids of garlic bulb are an important parameter from an industrial point of view. The bulbs containing higher TSS will be better suitable for processing of garlic bulbs to form pastes, powders, and spices. The data pertaining to the TSS influenced by various doses of potassium and sulphur is shown in Table 1. The pooled data of both seasons showed maximum TSS using 30 kg/ha S (41.5%) which was significantly higher than rest. Using 60 kg/

ha K showed greatest mean TSS (41.3%) among Potassium treatments, significantly different from all other treatments. During 2020-21, the highest TSS was obtained by using 30 kg/ S ha (41.4%) followed by 20 kg/ha (40.5%), which is significantly higher than all treatments. Use of K 60 kg/ha (41.2%) gave highest TSS followed by K 40 kg/ha (40.5%) being significantly different from all treatments. Similarly, during year 2021-22, 60 kg K per ha (41.5%) followed by 40 kg/ha (40.7%) gave the highest TSS being significantly different from all treatments. The use of S 30 kg/ha (41.5%) gave highest TSS followed by S 20 kg/ha (41.0%) among the sulphur treatments being at par statistically but higher significantly compared to other treatments. Results were in conformity with Divyasree *et al.* (2021) who used K2SO4 @ 60 kg/ha to get the highest TSS of 43.16°Brix. Malik *et al.* (2021) got the highest TSS of 40.81°Brix by using 45 kg/ S ha. While experimenting, Zyada and Bardisi (2018) used 150 kg K fed-1 to give the highest TSS of 37.77°Brix. Arisha *et al.* (2017) used 125 kg K_2O fed^{-1} to get a maximum TSS of 32.00°Brix. Chattoo *et al.* (2019) used 45 kg/ha of S to get a maximum TSS of 11.54°Brix. In another experiment, Diriba-Sheferaw *et al.* (2014) observed a maximum (21.73°Brix) TSS by using 60 kg/ha S. Singh *et al.* (2018) observed a maximum TSS of 30.51°Brix using S @ 60 kg/ha. Moreover, Patidar *et al.* (2017) used S @ 75 kg/ha to get a maximum TSS of 36.3°Brix.

Allicin

Garlic contains a colorless, odorless, and water-soluble amino acid called 'allin' (Magray *et al.* 2017). When garlic tissue is injured or damaged, this amino acid is converted into "allicin" by the enzyme alliinase. The allicin generated is unstable and quickly degenerates into Sulphur (S) containing compounds such as diallyl and triallyl sulphides (Lanzotti *et al.* 2014). Allicin is important for producing garlic powder, pastes and spices. The higher the allicin content, the better the quality of garlic in industrial point of view. The data pertaining to the allicin content, as influenced by potassium and sulphur, is shown in Table 2. Pooled data of both seasons showed maximum allicin content with 30 kg/ha S (12.64 mg/g) followed by 20 kg/ha S (12.44 mg/g) at statistically par but significantly higher than other treatments. The use of 60 kg/ha K gave the highest mean allicin (11.80 mg/g) among potassium treatments, followed by 20 kg/ha K (11.79 mg/g) and 40 kg/ha K (11.65 mg/g) which was statistically at par but significantly higher as compared to control. The result was similar during both seasons. During year 2020-21 and 2021-22, the highest allicin content with 30 kg/ha S (12.10 and 13.19 mg/g, respectively) followed by 20 kg/ha S (11.88 and 13.00 mg/g) being at par statistically with each other but higher significantly than rest. Use of 40 kg/ha K gave the greatest mean allicin content (12.80 mg/g) among potassium treatments during year 2021-22 followed by 60 kg/ha K (12.19 mg/g) and 20 kg/ha K (12.12 mg/g) being at par statistically but higher significantly than control. During year 2020-21, use of 60 kg/ha K (11.80 mg/g) gave highest yield followed by 20 kg/ha K (11.79 mg/g) and 40 Kg/ha K (11.65 mg/g) being at par statistically but higher significantly than control. Results were in conformity with Bloem et al. (2010) who used 45 kg/ ha S to get a maximum of 15.7 mg/g allicin.

Total protein content

Garlic's protein content depends upon K and S. The crop with higher protein content will have higher allicin and dry matter will be increased. The data pertaining to the total protein influenced by potassium and sulphur is shown in Table 2. Pooled data of both seasons showed maximum total protein with 60 kg/ha K (120.8 mg/g) being higher significantly than rest. Use of 30 kg/ha S gave the highest mean total protein (112.1 mg/g) among sulphur treatments, significantly higher than all other treatments. The result was similar during both seasons. During 2020-21and 2021-22, highest total protein was obtained by using 60 kg/ha K (122.6 and 119.1 mg/g) followed by 40 kg/ha (106.6 and 104.6 mg/g), significantly Use of S 30 kg/ha (111.3 and113.0 mg/g) gave highest total

Table 2: Influence of various levels of potassium and sulphur applications on allicin, phenols, total proteins, total sugars and reducing sugars (mg/g)

Treatments	*Allicin*			*Phenols*			*Total proteins*			*Total sugars*			*Reducing Sugars*		
	2020-21	*2021-22*	*Pooled data*	*2020-21*	*2021-22*	*Pooled data*	*2020-21*	*2021-22*	*Pooled data*	*2020-21*	*2021-22*	*Pooled data*	*2020-21*	*2021-22*	*Pooled data*
K_0	11.47	11.40	11.43	0.41	0.41	0.41	93.2	94.3	93.7	128.0	131.7	129.8	2.44	2.43	2.43
K_{20}	11.79	12.46	12.12	0.39	0.40	0.39	100.7	103.5	102.1	110.0	109.9	110.0	2.43	2.46	2.45
K_{40}	11.65	12.80	12.22	0.42	0.41	0.42	106.6	104.6	105.6	131.4	133.1	132.2	2.49	2.51	2.50
K_{60}	11.80	12.58	12.19	0.48	0.47	0.48	122.6	119.1	120.8	172.9	172.9	172.9	2.56	2.57	2.57
LSD (p<0.05) K	0.3	0.5	0.25	0.06	0.09	0.18	5.1	6.2	3.91	7.6	7.3	5.17	NS	NS	NS
S_0	11.31	10.63	10.97	0.39	0.38	0.39	95.9	95.3	95.6	108.1	109.6	108.8	2.46	2.30	2.38
S_{10}	11.41	12.43	11.92	0.41	0.41	0.40	107.9	105.9	106.9	139.5	141.6	140.5	2.48	2.47	2.47
S_{20}	11.88	13.00	12.44	0.47	0.45	0.46	108.2	107.4	107.7	149.1	149.0	149.1	2.43	2.55	2.49
S_{30}	12.10	13.19	12.64	0.45	0.46	0.46	111.3	113.0	112.1	145.6	147.4	146.5	2.55	2.65	2.60
LSD (p<0.05) S	0.2	0.4	0.22	0.08	0.07	0.15	5.2	6.3	3.89	7.7	7.4	5.16	NS	0.23	NS
LSD (p<0.05) K×S	NS	NS	NS	0.10	0.11	0.36	NS	NS	7.81	15.4	14.8	10.33	NS	NS	NS

protein followed by S 20 kg/ha (108.2 and 107.4 mg/g) and S 10 kg/ha (107.9 and 105.9 mg/g) being at par statistically among each other but higher significantly when compared to control. Results found were in conformity with Diriba-Sheferaw *et al.* (2014) who got maximum protein (12.17%) by applying S @ 60 kg/ha.

Phenols

The phenol content of plant is directly related to its tolerance against various diseases and pests and hence plays a vital role in plant health and is also important to get a good crop. The data pertaining to the phenols influenced by various doses of potassium and sulphur is shown in Table 3. Pooled data of both seasons showed maximum phenols content using 60 and 30 kg/ha S (0.54 mg/g) followed by 60 kg/ha K and 20 kg/ha S (0.51 mg/g) being at par among each other and significantly different than rest. During the year 2020-21, maximum phenols content was observed using 60 kg/ha K and 30 kg/ha S (0.53 mg/g) followed by 60 kg/ha K and 20 kg/ha S (0.51 mg/g) and 60 kg/ha K and 10 kg/ha S (0.45 mg/g) being at par among each other and significantly different than rest. In the year 2021-22, maximum phenols content was observed using 60 kg/ha K and 30 kg/ha S (0.54 mg/g) followed by 60 kg/ha K and 20 kg/ha S (0.51 mg/g) being at par among each other and significantly different than rest. The results found were in conformity with Divyasree *et al.* (2021) who used potassium sulphate @ 60 kg/ha to get maximum phenols (0.49 mg/g).

Total sugars

The total sugar content in garlic is an important quality parameter that has industrial importance. The data pertaining to the total sugars influenced by various doses of potassium and sulphur is shown in Table 4. Pooled data of both seasons showed maximum total sugars content using 60 kg/ha K and 30 kg/ha S (182.2 mg/g) followed by 60 kg/ha K and 20 kg/ha S (175.5 mg/g) and 60 kg/ha K and 20 kg/ha S (174.8 mg/g) being at par among each other and significantly different than rest. During year 2020-21, maximum total sugars content was observed using 60 kg/ha K and 30 kg/ha S (180.6 mg/ g) followed by 60 kg/ha K and 20 kg/ha S (177.3 mg/g) and 60 kg/ha K and 20 kg/ha S (173.3 mg/g) being at par among each other and significantly different than rest. In year 2021-22, maximum total sugars content was observed using 60 kg/ha K and 30 kg/ha S (183.6 mg/g) followed by 60 kg/ha K and 20 kg/ha S (176.3 mg/g) and 60 kg/ha K and 20 kg/ha S (173.6 mg/g) being at par among each other and significantly different than rest.

Reducing sugars

The total sugars content in garlic is an important quality parameter that has industrial importance. The data pertaining to the reducing sugars influenced by various doses of potassium and sulphur is shown in Table 4. Pooled data of both seasons failed to show any significant difference in reducing sugars with use of potassium and sulphur treatments. During year 2020-21, the use of potassium and

Table 3: Influence of various levels of potassium and sulphur applications on phenols in (mg/g)

Treatments	S_0	S_{10}	S_{20}	S_{30}	*Mean*
2020-21					
K_0	0.36	0.39	0.45	0.45	0.41
K_{20}	0.33	0.36	0.42	0.45	0.39
K_{40}	0.42	0.42	0.48	0.37	0.42
K_{60}	0.45	0.45	0.51	0.53	0.48
Mean	0.39	0.41	0.47	0.45	
LSD (p<0.05)	0.06 (K)	0.08 (S)	0.10 (K×S)		
2021-22					
K_0	0.37	0.39	0.42	0.47	0.41
K_{20}	0.33	0.39	0.43	0.45	0.40
K_{40}	0.41	0.41	0.45	0.39	0.41
K_{60}	0.42	0.43	0.51	0.54	0.47
Mean	0.38	0.41	0.45	0.46	
LSD (p<0.05)	0.09 (K)	0.07 (S)	0.11 (K×S)		
Pooled data					
K_0	0.37	0.40	0.44	0.46	0.41
K_{20}	0.34	0.38	0.43	0.46	0.39
K_{40}	0.42	0.42	0.47	0.38	0.42
K_{60}	0.44	0.44	0.51	0.54	0.48
Mean	0.39	0.40	0.46	0.46	
LSD (p<0.05)	0.08 (K)	0.05 (S)	0.09 (K×S)		

Table 4: Influence of various levels of potassium and sulphur applications on total sugars (mg/g)

Treatments	S_0	S_{10}	S_{20}	S_{30}	*Mean*
2020-21					
K_0	73.0	154.3	147.0	137.6	128.0
K_{20}	93.3	107.6	129.3	110.0	110.0
K_{40}	105.6	122.6	143.0	154.3	131.4
K_{60}	160.3	173.3	177.3	180.6	172.9
Mean	108.1	139.5	149.1	145.6	
LSD (p<0.05)	7.6 (K)	7.7 (S)	15.4 (K×S)		
2021-22					
K_0	77.3	157.3	150.0	142.3	131.7
K_{20}	96.6	105.0	126.0	112.0	109.9
K_{40}	106.6	128.0	146.3	151.6	133.1
K_{60}	158.0	176.3	173.6	183.6	172.9
Mean	109.6	141.6	149.0	147.4	
LSD (p<0.05)	7.3 (K)	7.4 (S)	14.8 (K×S)		
Pooled data					
K_0	75.2	155.8	148.5	140.0	129.8
K_{20}	95.0	106.3	127.7	111.0	110.0
K_{40}	106.2	125.3	144.7	153.0	132.2
K_{60}	159.2	174.8	175.5	182.2	172.9
Mean	108.8	140.5	149.1	146.5	
LSD (p<0.05)	5.2 (K)	5.1 (S)	10.3 (K×S)		

sulphur treatments didn't lead to any significant difference in reducing sugars. During year 2021-22, potassium treatments failed to show any significant result in reducing sugars, whereas the sulphur treatments showed significant differences in reducing sugars. Sulphur @ 30 kg/ha gave the highest reducing sugars, followed by S 20 and S @10 kg/ha. They were observed to at par statistically among each other but higher significantly than control. It is concluded from the present investigation that application of potash @ 60 kg/ha along with sulfur @ 30 kg/ha gave best results in all parameters like TSS, total protein, allicin, ascorbic acid, dry matter, total minerals and total sugars in Punjab region.

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सारांश

रबी मौसम में लहसुन की गुणवत्ता पर पोटैशियम और सल्फर के प्रभाव का अध्ययन करने के लिए वर्ष 2020-21 और वर्ष 2021-22 के दौरान सब्जी अनुसंधान प्रक्षेत्र और जैव रसायन प्रयोगशाला, पंजाब कृषि विश्वविद्यालय, लुधियाना (पंजाब) में प्रयोग किया गया। प्रयोग में पोटैशियम के चार स्तरों (0, 20, 40 और 60 किग्रा./हेक्टेयर) और सल्फर के चार स्तरों (0, 10, 20 और 30 किग्रा./ हेक्टेयर) के साथ कुल सोलह उपचार शामिल थे। इसे यादृच्छिक पूर्ण ब्लॉक डिजाइन में लगाकर तीन बार पुनरावृत्ति की गयी। किस्म 'पी.जी.-18' का उपयोग पौध सामग्री के रूप में किया गया। पोटैशियम और सल्फर को आधारीय खुराक के रूप में डाला गया। परिणाम से स्पष्ट हुआ कि इन पोषक तत्वों के प्रयोग से गुणवत्ता प्रभावित हुई। अधिकतम एलिलीन (12.19 मिग्रा./ग्राम और 12.64 मिग्रा./ग्राम), टी.एस.एस. (41.38 और 41.58), एस्कार्बिक एसीड (21.64 मिग्रा./100 ग्राम सूखा वजन और 21.81 मिग्रा./100 ग्राम सूखा वजन, कुल खनिज (53.17 मिग्रा./100 ग्राम सूखा वजन और 53.56 मिग्रा./100 ग्राम सूखा वजन), शुष्क पदार्थ (42.40 प्रतिशत और 42.97 प्रतिशत), कुल प्रोटीन (120.8 मिग्रा./ग्राम और 112.1 मिग्रा./ग्राम) 60 किग्रा./हेक्टेयर पोटैशियम और 30 किग्रा./हेक्टेयर सल्फर के प्रयोग से किया गया। फिनोल (0.54 मिग्रा./लीटर) और कुल शर्करा (182.2 मिगा. /ग्राम) की अधिकतम मात्रा 60 किग्रा./हेक्टेयर पोटैशियम और 30 किगा./सल्फर के संयोजन से दर्ज किया गया।