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Effect of Sulphur on Yield and Quality of Potato (*Solanum tuberosum* L.)

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ABSTRACT

Quality attributes of potato tubers particularly size of tubers, dry matter, starch and sugar contents are the areas of major concern of potato growers as well as processors. Hence, a field experiment was carried out to study the effect of five levels of sulphur application on yield and quality attributes of four varieties of potato under Malwa agro-climatic conditions of Madhya Pradesh in India. The treatments were replicated thrice in factorial randomized block design. Healthy potato tubers of uniform size (40-45 g) were planted at a spacing of 60 cm×25 cm. Significant variation was observed in different varieties of potato for yield and quality attributes. Maximum tuber yield per plant and large size tuber yield was recorded with cv Kufri Pushkar. Highest dry matter content, specific gravity, total sugar and starch content were found with Kufri Chipsona-2 followed by Kufri Chipsona-1. Sulphur application in potato showed significant influence on quality and yield. These parameters increased with increasing dose of sulphur upto 45 kg ha^{-1} thereafter it showed non significant improvement. Highest tuber yield, large size and medium size tuber yield, dry matter content, specific gravity, sugar content and starch content were found with application of 45 kg ha^{-1} sulphur. Combined effect of varieties and sulphur levels showed significant influence only on starch content in tuber. Kufri Chipsona-1 and Kufri Chipsona-2 were at par to each other and found superior over other varieties as far as quality attributes of the produce are concerned. Kufri Pushkar was superior in terms of yield.

Key words: Potato, sulphur, variety, yield, sugar, quality

INTRODUCTION

Potato (*Solanum tuberosum* L.) is an important crop of the world. It is consumed in different forms such as boiled or fried and many different processed products like chips, french fries, flakes, powder, potato papad etc. which are enjoyed across the generations and continents. Quality attributes of potato tubers particularly size of tubers, dry matter, starch and sugar contents are of prime concern of potato growers, in order to fetch good prices of their produce from processors demanding potato for further value addition (Pandey and Sarkar, 2005; Pandey *et al*., 2009).

Genetical makeup has great influence on yield and quality of potato tubers. Various varieties of potato having wide variation in their yield potential and quality attributes have been evolved (Marwaha *et al*., 2010). These varieties further show variation in their attributes under different agro climatic conditions. The influence of location and cultivars on quality of potato tubers have been reported by researchers (Uppal and Paul, 2001; Kumar *et al*., 2003). Sulphur is one of sixteen essential nutrient elements and fourth major nutrient after NPK, required by plants for proper

growth and yield as it is known to take part in many reactions in all living cells (Sud and Sharma, 2002). Sulphur deficient plants had poor utilization of nitrogen, phosphorus and potash and a significant reduction of catalase activities at all age (Nasreen *et al*., 2003). Intensive cropping and use of high-grade fertilizers have caused the depletion of sulphur in soils. Decrease in tuber dry matter yield and concentrations of dry matter, starch and essential amino acids particularly cystine and leucine were observed with sulphur deficiency (Eppendorfer and Eggum, 1994a; Petitte and Ormrod, 1988). Sulphur has a direct effect on soil properties as it may reduce soil pH which improves the availability of microelements such as Fe, Zn, Mn and Cu as well as crop yield and its related characteristics (Tantawy *et al*., 2009). The need of application of sulphur along with its beneficial effects on yield and quality has been reported by earlier workers (Chettri *et al*., 2002; Prakash *et al*., 1997; Singh *et al*., 1995). Hence, an experiment was conducted to determine the effect of sulphur on the yield and quality of potato cultivars under Malwa agroclimatic conditions of Madhya Pradesh, India.

MATERIALS AND METHODS

A field investigation was carried out at Bahadari Research Farm (Around 24.03°N 75.08°E) of College of Horticulture, Mandsaur during 2008-09. The soil of the research field was clay in texture having 7.10 pH. Twenty treatment combinations of four varieties (Kufri Chipsona-1, Kufri Chipsona-2, Kufri Jyoti and Kufri Pushkar) and five levels of sulphur (0, 10, 15, 30, 45 and 60 kg ha^{-1}) were replicated thrice in factorial randomized block design. Healthy potato tubers of uniform size (40-45 g) were planted at a spacing of 60 cm×25 cm. Standard package of practices were followed to raise the crop. Tubers under all the treatments were dig out 115 days after sowing. The observations were recorded on grade wise tuber yield (% by weight) viz. large size (>60 g), medium size (25-60 g) and small size tuber (<25 g), tuber yield per plant and quality parameters, i.e., tuber dry matter (%), specific gravity, total sugar (%) and starch (%) content in potato tuber. Dry matter was determined by oven drying method in which properly chopped 100 g composite samples of each treatment was dried at 80°C till constant weight (Singh *et al*., 2003) reached. Total sugar and starch contents were determined by the methods as suggested by Sadasivam and Manickam (1992). For determination of specific gravity, 50 potato tubers were taken from each treatment. Specific gravity was calculated with the following formula:

$$\text{Specific gravity} = \frac{\text{Weight of tuber in air}}{\text{Weight of tuber in air} - \text{Weight of tuber in water}}$$

RESULTS AND DISCUSSION

Tuber yield: In the present investigation tuber yield per plant was found to be maximum with Kufri Pushkar followed by Kufri Chipsona-1, Kufri Chipsona-2 and Kufri Jyoti (Table 1). Kufri Pushkar was significantly superior over other varieties. However, difference between tuber yield per plant for Kufri Chipsona-1 and Kufri Chipsona-2 were non significant. Kufri Jyoti recorded tuber yield per plant statistically at par to Kufri Chipsona-2. Similarly, Kumar *et al*. (2008) and Jaiswal *et al*. (2008) also reported significant variation in tuber yield of different potato varieties.

Grade wise tuber yield (%) of potato recorded for different varieties showed significant difference (Table 1). Maximum small size tuber yield (%) was found with Kufri Pushkar which was statistically at par to Kufri Jyoti and Kufri Chipsona-2. Medium size tuber yield (%) was highest in Kufri Jyoti, which showed non significant difference with Kufri Chipsona-1 and Kufri

Table 1: Effect of varieties on yield of potato tuber

Varieties	Grade wise tuber yield (%)			Tuber yield per plant (kg)
	Small size	Medium size	Large size	
Kufri Chipsona-1	11.49	43.48	44.79	0.490
Kufri Chipsona-2	12.87	42.52	44.32	0.450
Kufri Jyoti	12.84	44.17	42.88	0.400
Kufri Pushkar	13.98	37.79	47.73	0.630
SEm±	0.45	1.01	1.17	0.021
$CD_{0.05}$	1.29	2.90	3.34	0.060

Table 2: Effect of sulphur application on yield of potato tuber

Sulphur levels (kg ha^{-1})	Grade wise tuber yield (%)			Tuber yield per plant (kg)
	Small size	Medium size	Large size	
0	19.24	39.41	40.91	0.430
15	14.92	40.91	44.08	0.460
30	11.84	42.01	45.76	0.490
45	7.90	44.39	47.27	0.570
60	10.09	43.26	46.63	0.530
SEm±	0.50	1.13	1.30	0.023
$CD_{0.05}$	1.44	3.25	3.74	0.067

Chipsona-2. Large size tuber yield (%) was maximum in Kufri Pushkar followed by Kufri Chipsona-1, Kufri Chipsona-2 and Kufri Jyoti in descending order. There was no remarkable difference between Kufri Chipsona-1 and Kufri Pushkar for large size tuber yield (%). Higher tuberisation and bulking capacity might have resulted in more large size tuber yield (%) and tuber yield per plant in Kufri Pushkar. Bhardwaj *et al.* (2008) also found significant difference among different genotypes for grade wise tuber yield.

Tuber yield per plant showed maximum values with 45 kg ha^{-1} sulphur which was significantly superior over control, 15 and 30 kg ha^{-1} sulphur application. Improvement in tuber yield was not observed with 60 kg ha^{-1} sulphur application (Table 2). More availability of sulphur, which is an important component in plant nutrition, might have increased the yield in potato upto a limit. Sulphur levels showed significant influence on grade wise tuber yield (%) and yield per plant in potato (Table 2). Small size tuber yield (%) was the maximum under control followed by 15, 30, 60 and 45 kg ha^{-1} in descending order. Medium size tuber yield (%) was maximum under 45 kg ha^{-1} followed by 60, 30 kg ha^{-1} sulphur with non significant difference. Highest large size tuber yield (%) was found with 45 kg ha^{-1} sulphur followed by 60, 30 and 15 kg ha^{-1} sulphur application. In general, there was increase in large size and medium size tuber yield (%) with increase in sulphur level up to 45 kg ha^{-1}, which showed reduction at further high level. However, small size tuber yield (%) recorded reverse trend and showed decrease in small size tuber with increasing doses of sulphur up to 45 kg ha^{-1}. These results are in line with Sud and Sharma (2002) who reported that increase in tuber yield with increasing sulphur levels may be attributed to its role in better partitioning of the photosynthates in the shoot and tubers. Similarly, Lalitha *et al.* (2002) have also reported significant effect on grade wise tuber yield and increase in bulking rate with sulphur application. But heavy applications of sulphur can result in yield reductions (Eddins, 1934). These findings are also in agreement with those of Nasreen *et al.* (2007) in onion.

Table 3: Effect of varieties on quality of potato tuber

Varieties	Dry matter (%)	Specific gravity	Total sugar content (%)	Starch content (%)
Kufri Chipsona-1	21.99	1.090	0.310	17.90
Kufri Chipsona-2	22.63	1.100	0.330	18.30
Kufri Jyoti	20.01	1.060	0.290	16.37
Kufri Pushkar	18.05	1.020	0.260	16.16
SEm±	0.45	0.020	0.006	0.15
$CD_{0.05}$	1.28	0.058	0.018	0.45

Table 4: Effect of sulphur on quality of potato tuber

Sulphur levels (kg ha^{-1})	Dry matter (%)	Specific gravity	Total sugar content (%)	Starch content (%)
0	18.60	1.020	0.240	15.32
15	19.44	1.040	0.280	16.22
30	20.74	1.060	0.300	17.35
45	22.56	1.110	0.340	18.78
60	22.00	1.090	0.330	18.27
SEm±	0.50	0.023	0.007	0.17
$CD_{0.05}$	1.44	0.065	0.020	0.50

Quality parameters: Quality parameters, i.e., dry matter, specific gravity, total sugar content, starch content were observed and found that they were differed significantly with potato varieties (Table 3). Dry matter content recorded in potato tuber showed highest value in Kufri Chipsona-2 followed by Kufri Chipsona-1 with no remarkable difference. Kufri Jyoti was significantly lower than Kufri Chipsona-2 but at par to Kufri Chipsona-1. Lowest dry matter content in tuber was observed in variety Kufri Pushkar. Highest specific gravity was recorded in tubers of Kufri Chipsona-2 followed by Kufri Chipsona-1 and Kufri Jyoti with at par performance. Lowest specific gravity was determined in tubers of Kufri Pushkar. Kufri Chipsona-2 recorded highest total sugar content in tuber followed by Kufri Chipsona-1 and Kufri Jyoti. Total sugar content was observed lowest in tubers of variety Kufri Pushkar. Starch content was maximum in Kufri Chipsona-2 tubers followed by Kufri Chipsona-1 and Kufri Jyoti. However no remarkable difference was observed in starch content in tubers of Kufri Chipsona-1 and Kufri Chipsona-2. Lowest starch content was found with Kufri Pushkar. Jaiswal *et al.* (2008) and Ullah and Saikia (2008) also reported differences in quality parameters among different varieties of potato.

Effect of sulphur application on quality parameters of potato after harvesting is shown in Table 4. Sulphur application increased dry matter content in tuber up to 45 kg ha^{-1}. Thereafter, further increase in sulphur did not showed any remarkable influence. Specific gravity increased with increasing dose of sulphur up to 45 kg ha^{-1}. However, there was no significant difference in specific gravity of tubers under 30, 45 and 60 kg ha^{-1} sulphur levels. Each incremental dose of sulphur enhances the total sugar content in potato tuber up to 45 kg ha^{-1}. Further increase in sulphur dose recorded slight reduction in sugar content. There was no significant difference in sugar content of tuber at 15 and 30 kg ha^{-1} sulphur as well as 45 and 60 kg ha^{-1}. Starch content was found maximum with application of 45 kg ha^{-1} sulphur which was significantly superior over other sulphur levels. Lowest starch content was recorded under control. Ramamurthy and Devi (1982) also reported significant increase in dry matter content in tuber with sulphur application. However, they did not find any significant effect on specific gravity, starch and total sugar content. Sulphur deficiency reduced the starch content of potatoes (Eppendorfer and Eggum, 1994b).

Table 5: Combined effect of varieties and sulphur levels on starch content (%) in potato tuber

	Sulphur levels (kg ha^{-1}) (S)				
Varieties (V)	0	15	30	45	60
Kufri Chipsona-1	15.96	17.59	18.06	19.16	19.75
Kufri Chipsona-2	16.67	17.82	18.11	19.66	18.26
Kufri Jyoti	14.55	15.23	15.98	18.21	17.89
Kufri Pushkar	14.08	14.24	17.23	18.10	17.16
SEm± (V×S)			0.35		
$CD_{0.05}$			0.99		

Singh *et al.* (1995) also found significant increase in dry matter content in potato tuber with sulphur application. Sulphur being a component of sulphur containing amino acid as well as involved in sulpho-hydral bonds in polypeptides, also component of protein enzyme involved in chlorophyll, starch and protein synthesis. Involvement of sulphur in these biochemical processes in plant metabolism may be the cause for increased starch synthesis and production of large size tubers (Lalitha *et al.*, 2002).

Combined effect of varieties and sulphur level had non significant influence on dry matter content, specific gravity and total sugar content in tuber. Though, it affected starch content in tuber significantly (Table 5). Kufri Chipsona-1 along with application of 60 kg ha^{-1} sulphur recorded highest starch content. Though, it was statistically at par to combination of Kufri Chipsona-2 under 45 kg ha^{-1} sulphur and Kufri Chipsona-1 under 45 kg ha^{-1} sulphur.

Hence, it may be concluded based on the present field experiment that variety as well as sulphur has significant influence on yield and quality attributes of potato tubers. In the present study, application of 45 kg ha^{-1} sulphur excelled over other doses for both tuber yield and quality attributes. Among the varieties, Kufri Chipsona-1 and Kufri Chipsona-2 were at par to each other and found superior over other varieties as far as quality attributes of the produce are concerned. Kufri Pushkar was superior in terms of yield.

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