Annals of Plant and Soil Research 17 (1): 45-49 (2015)

EFFECT OF SULPHUR ON GROWTH, YIELD AND ECONOMICS OF POTATO CULTIVARS

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Received: May, 2014; Revised accepted: November, 2014

ABSTRACT

An experiment was conducted at College of Horticulture, Mandsaur (M.P.) during rabi season of 2008-09 to evaluate the four potato cultivars (Kufri Chipsona-1, Kufri Chipsona-2, Kufri Jyoti, Kufri Pushkar) under five sulphur (0, 15, 30, 45, and 60 kgha^{-1}) levels. Twenty treatment combinations were replicated thrice in factorial randomized block design. Significant variations were observed in different varieties of potato for growth parameters, yield attributes, and tuber yield. Maximum number of sprouts was recorded in Kufri Pushkar followed by Kufri Chipsona-1 and lowest in Kufri Jyoti. Kufri Chipsona-2 produced tallest plants and higher number of leaves per plant. Fresh weight of shoot per plant number of tuber per plant (8.33), average tuber weight (167.3g) and total tuber yield (41.90t ha^{-1}) was recorded maximum with Kufri Pushkar. There was an increase in these parameters with increasing dose of sulphur upto 45 kg ha^{-1}. Further increase in sulphur dose either reduced the values or showed non significant improvement. Highest number of sprout per tuber (7.5), plant height (41.7, 47.9, 59.2cm), number of leaves per plant (29.6, 52.0, 76.5), fresh weight of shoot per plant (50.3, 64.2, 76.5 g), tuber per plant (8.58), tuber weight (166.56g) as well as total tuber yield (37.74 t ha^{-1}) were recorded with 45 kg S ha^{-1}. Highest net return (₹.188890.2ha^{-1}) as well as B:C ratio (3.02) were recorded with Kufri Pushkar. Among the sulphur levels, maximum net return (₹.163100.5ha^{-1}) and B:C ratio (2.57) was obtained with 45 kg S ha^{-1}.

Key words: Potato, sulphur, growth, yield, economics

INTRODUCTION

Potato (*Solanum tuberosum* L.) is the most popular food crop of the world. It ranks fourth in importance after rice, wheat and maize. Potato is a nutritious, easily digestible, wholesome food. It is one of the widely grown crops in India. The country produced 12.42% of the world's potatoes from 10.32% of the total global potato growing area with productivity level (22.8tha^{-1}) higher than the world's average (18.9t ha^{-1}) during the year 2012-13. India stands second in world potato production (NHB, 2014). Genetic architecture has great influence on yield and quality of potato. Various varieties of potato having wide variation in their yield potential and quality attributes have been evolved. These varieties further show variation in their attributes under different agro climatic conditions. Kufri Jyoti is widely adopted potato variety grown for table potato as well as processing purpose. Kufri Chipsona-1 and Kufri Chipsona-2 are processing potato varieties. While Kufri Pushkar has a good keeping and cooking quality, low dry matter content with medium size tuber. It is a high yielding potato variety (Kang *et al.*, 2007).Sulphur is fourth major nutrient after NPK, required by plants. Its application is less expensive but can give higher profits than other nutrients (Tandon and Messick, 2007). Sulphur plays an essential role in chlorophyll formation and therefore helps to give plants their green colour. It is the key component of balanced nutrition required to potato. Intensive cropping and use of high-grade fertilizers have resulted in depletion of sulphur in soils. Various workers have reported the need of application of sulphur fertilizers along with its beneficial effects on yield and quality (Chettri *et al.*, 2002, Jaga and Sharma, 2013 and Choudhary *et al*., 2013). Keeping these facts in view an experiment was conducted to see the response of potato cultivars to sulphur levels under agroclimatic conditions of Mandsaur, Madhya Pradesh.

MATERIALS AND METHODS

The experiment was conducted during Rabi season of 2008-09 at "Bahadari farm", College of Horticulture, Mandsaur, Madhya Pradesh. Mandsaur is situated in western part of Madhya Pradesh, between latitude of 23o 45' to 24^{o}13' North, longitude of 74^{o} 44' to 75^{o}18' East and at an altitude of 435.20 m above sea level. This region lies under Malwa Plateau Agro climatic zone of the state. Mandsaur is having sub-tropical and semi-arid climatic conditions with a temperature range of 5oC minimum and 44oC maximum in winter and summer respectively. In this region maximum rainfall is received during mid June to September. The average annual rainfall is 544.05 mm. South - West monsoon is responsible for major part of annual precipitation. The soil of the experimental field was Clay in texture with uniform topography. The soil pH was 7.1 having

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available N, P, K and S content in soil 140, 27, 390 and 27kgha^{-1}, respectively. The experiment was laid out in factorial randomised block design with three replications, taking four potato varieties Kufri Chipsona-1, Kufri Chipsona-2, Kufri Jyoti, Kufri Pushkar and five sulphur doses (0,15, 30, 45 and 60 kgha^{-1}). A uniform dose of nutrients was applied @ N 120, P_2O_5 80 and K_2O 100 kg ha^{-1} in all the plots. Full dose of P, K, S and half dose of N was given as basal application. Remaining half dose of N was applied in two equal splits i.e. 1st at 25 days after planting and 2nd at 45 DAP. The N, P, K and S were supplied through urea, di ammonium phosphate, muriate of potash (MOP) and elemental sulphur, respectively. Healthy and uniform size tubers were planted on 16 October at spacing of 60 cm row to row and 25 cm plant to plant. Observations were recorded on growth parameters viz., number of sprout per tuber (at 45 DAP), plant height (at 30, 60, 90 DAP), number of leaves (at 30, 60, 90 DAP), fresh and dry weight of shoot (at 30, 60, 90 DAP), yield parameters viz., number of tuber per plant, tuber weight (g) and tuber yield per hectare. Economics of different treatments was worked out on the basis of prevailing prices of inputs and output. The prices of inputs at the time of experiments were DAP @ ` 980/q, urea @ ` 504/q, MOP @ ` 550/q, elemental sulphur @ ` 60/kg, potato seed tuber @ `1750/q. The potato tuber sale rate was @ ` 600/q. Sulphur use efficiency (SUE) was calculated as per procedure (Sud *et al*., 1996).

RESULTS AND DISCUSSION

Growth parameters

Results (Table 1) showed that varieties had exerted significant effect on growth parameters. There was linear increase in plant height, number of leaves, fresh and dry weight of shoot per plant upto 90 days after planting in all the varieties. Though, the fresh and dry weight of shoot per plant at 45 DAP showed non significant effect. Maximum number of sprouts was recorded in Kufri Pushkar followed by Kufri Chipsona-1, Kufri Chipsona-2 and Kufri Jyoti. Maximum plant height was recorded with Kufri Chipsona-2, which was significantly superior over other varieties. It was followed by Kufri Chipsona-1, Kufri Pushkar and lowest plant height was recorded with Kufri Jyoti. Maximum number of leaves was observed with Kufri Chipsona-2, which was significantly superior over other varieties. Kufri Pushkar recorded maximum fresh weight of shoot per plant followed by Kufri Chipsona-1, Kufri Chipsona-2 and Kufri Jyoti in descending order. Different genetic makeup might have resulted in varied potential for sprouting as well as photosynthesis, which resulted in more food material accumulation and ultimately high fresh and dry weight of shoot in Kufri Pushkar. Kumar *et al.* (2008) also reported significant difference in growth parameters under different variety of potato.

Table 1: Growth parameters in potato as influenced by varieties and sulphur levels at different stages

Treatment	Sprouts per tuber	Plant height (cm)			Leaves per plant			Fresh weight of shoot/plant (g)			Dry weight of shoot/plant (g)		
		45 DAP	60 DAP	90 DAP	45 DAP	60 DAP	90 DAP	45 DAP	60 DAP	90 DAP	45 DAP	60 DAP	90 DAP
Varieties (V)													
(Kufri Chipsona-1)	6.5	38.0	41.3	54.3	26.1	46.4	67.5	41.3	54.4	60.3	4.3	7.5	10.1
(Kufri Chipsona-2)	5.7	49.7	56.0	67.5	32.0	51.0	97.7	38.9	51.4	59.6	4.2	7.0	9.9
(Kufri Jyoti)	5.5	32.4	37.6	48.6	20.8	41.3	54.3	37.3	46.7	53.8	3.8	6.5	9.7
(Kufri Pushkar)	7.7	35.2	40.6	51.7	21.8	46.2	64.7	42.1	59.5	65.3	5.0	8.1	11.2
SE m±	0.27	1.08	1.29	1.45	1.29	2.27	2.36	1.96	2.08	2.19	0.30	0.34	0.39
CD (P=0.05)	0.77	3.11	3.69	4.14	3.70	6.52	6.76	NS	5.97	6.02	NS	0.97	1.11
Sulphur l (kg ha^{-1})													
0	5.5	36.2	40.7	52.3	21.7	38.8	65.1	29.4	42.2	45.4	3.2	5.9	8.0
15	5.7	37.0	42.1	53.6	22.4	42.7	69.9	38.3	47.2	52.8	3.8	6.6	9.5
30	6.2	39.0	42.8	55.3	25.5	46.9	70.6	40.0	54.1	59.3	4.4	7.1	10.5
45	7.5	41.7	47.9	59.2	29.6	52.0	76.5	50.3	64.2	76.5	5.5	9.0	12.0
60	6.9	40.3	45.9	57.2	26.7	50.7	73.2	41.5	57.5	66.0	4.7	8.0	11.2
SE m±	0.30	1.21	1.44	1.62	1.44	2.54	2.64	2.19	2.33	3.01	0.34	0.38	0.43
CD (P=0.05)	0.87	3.48	4.12	4.64	4.14	7.28	7.55	6.27	6.68	8.62	0.99	1.09	1.24

The findings (Table1) revealed significant influence of sulphur application on all the growth parameters at all the stages of growth. Among the sulphur doses, highest number of sprout per tuber was found with the application of 45 kg S ha^{-1}. Further increase in sulphur level did not show any remarkable influence. Similarly, plant height, number of leaves per plant and fresh and dry weight of shoot per plant

also showed increase up to 45 kgha^{-1} sulphur application. Further increase in sulphur level i.e. 60 kgha^{-1} had no significant improvement in these growth parameters. The increase in growth parameters under sulphur application might be due to improved sulphur availability, which in turn enhanced the plant metabolism and photosynthetic activity resulting into better growth. These findings are in agreement with Singh and Shrivastava (1995) and Jat *et al.* (2013).

Yield attributes and yield

Different varieties as well as sulphur levels had significant influence on number of tuber per plant, average tuber weight and tuber yield. Maximum number of tuber per plant was recorded with Kufri Pushkar followed by Kufri Chipsona-1, Kufri Chipsona-2 and Kufri Jyoti in descending order. Kufri Pushkar recorded significantly higher number of tuber per plant as compared to Kufri Jyoti and Kufri Chipsona-2. Highest average tuber weight was recorded with Kufri Pushkar, which was significantly superior over other varieties. Rest of the varieties followed the order as Kufri Chipsona-1 > Kufri Chipsona-2 > Kufri Jyoti. There was no remarkable difference between tuber weight of Kufri Chipsona-1 and Kufri Chipsona-2 and between Kufri Chipsona-2 and Kufri Jyoti. Genetic background of the varieties might be responsible for these differences in yield attributes. Tuber yield was recorded highest with Kufri Pushkar, which was significantly superior over other varieties. Rest of the varieties followed the order of Kufri Chipsona-1 > Kufri Chipsona-2 and > Kufri Jyoti for tuber yield of potato. The difference between tuber yield of Kufri Chipsona-1 and Kufri Chipsona-2 was not significant. Kufri Jyoti yielded at par to Kufri Chipsona-2. Higher growth parameters along with greater tuberisation and bulking capacity due to genetic makeup might have resulted in greater number of tuber, average tuber weight, maximum total tuber yield in Kufri Pushkar. Jaiswal *et al.* (2008) and Kumar *et al.* (2008) also reported significant variation in yield parameters and total tuber yield of different potato varieties. Sulphur levels showed significant influence on yield parameters and yield in potato. Highest number of tuber per plant was recorded at 45 kg ha^{-1} sulphur, which was significantly superior over control and 15 kg ha^{-1} sulphur levels. Application of sulphur at the rate of 30 kg ha^{-1} and 60 kg ha^{-1} showed non-significant difference in number of tuber per plant as compared to 45 kg ha^{-1} sulphur level. Average tuber weight was recorded highest with application of 45 kg ha^{-1} sulphur which was significantly superior over all lower levels of sulphur. Further increase in sulphur level showed no significant response. The improvement in yield attributes with the application of sulphur could be ascribed to its pivotal role in regulating physiological and metabolic system in plant. Sulphur enhances cell multiplication, elongation and expansion, chlorophyll synthesis resulting in higher dry matter accumulation consequently higher yield attributes. These results are corroborated with those reported by Singh *et al.*(2012).Total tuber yield was found maximum with 45 kg S ha^{-1} which was significantly higher than control, 15 kg ha^{-1} and 30 kgha^{-1} sulphur levels. While the differences in tuber yield at 45 kg ha^{-1} and 60 kg ha^{-1} sulphur were not remarkable. These results showed that there was enhancement in yield parameters and yield up to 45 kg ha^{-1} sulphur and further increase in sulphur level had no significant positive improvement.

Table 2: Yield and economics of potato cultivars as affected by sulphur

Treatments	Number of tuber per plant	Tuber weight (g)	Tuber (t ha^{-1})	Net income (₹. ha^{-1})	B:C Ratio	SUE (q kg^{-1})
Varieties (V)						
(Kufri Chipsona-1)	8.00	138.02	32.70	133731.0	2.14	1.03
(Kufri Chipsona-2)	7.27	133.60	30.01	118103.4	1.88	1.05
(Kufri Jyoti)	6.47	117.88	27.11	100196.6	1.60	1.59
(Kufri Pushkar)	8.33	167.30	41.90	188890.2	3.02	0.74
SEm±	0.37	7.02	1.12	6749.5	0.11	-
CD (P=0.05)	1.06	20.13	3.23	19338.7	0.31	-
Sulphur (S) kg/ha						
0	6.67	119.48	28.73	111683.5	1.84	0
15	7.00	129.16	30.40	120850.5	1.96	1.12
30	7.50	131.55	32.75	134017.0	2.14	1.34
45	8.58	166.56	37.74	163100.5	2.57	2.01
60	7.83	149.25	35.13	146500.0	2.28	1.07
SE m±	0.42	7.85	1.26	7546.2	0.12	-
CD (P=0.05)	1.20	22.50	3.60	21621.3	0.35	-

More availability of sulphur which is an important component in plant nutrition might have increased the growth parameters, yield parameters and finally yield in potato due to increased metabolic activities, photosynthesis, assimilation and bulking rate. These findings are in line with those of Lalitha *et al.* (2002) and Sud and Sharma (2002).

Sulphur use efficiency (SUE)

The data (Table 2) showed variation among potato varieties for Sulphur use efficiency. Highest SUE (1.59 q kg^{-1}) was recorded with Kufri Jyoti which was followed by Kufri Chipsona-2, Kufri Chipsona-1. Kufri Pushkar had lowest SUE (0.74 q kg^{-1}). The efficient cultivars give higher tuber yield under nutrient stress than less efficient cultivar. Jatav *et al.* (2013) reported significant variation in potato varieties for N use efficiency.Application of sulphur had registered remarkable influence on SUE in potato. There was increase in sulphur use efficiency with increasing dose of sulphur application upto 45 kg ha^{-1}. Further increase in sulphur levels resulted in lower SUE. This may be due to the fact that input-output relationship follows the law of diminishing return as far as the relationship between sulphur and yield is concerned. Similar findings have been reported by Sud *et al*. (1996) and Jatav *et al*. (2013).

Economics

Economic evaluation of treatments showed that cost of cultivation increased with increasing level of sulphur. Gross income was recorded highest with variety Kufri Pushkar under 45 kg ha^{-1} sulphur. It was followed by Kufri Pushkar under 60 kg ha^{-1}, Kufri Pushkar under 30 $kgha^{-1}$, Kufri Pushkar under 15 kg S ha^{-1}, Kufri Pushkar without sulphur, Kufri Chipsona-1 under 45 kg ha^{-1}, Kufri Chipsona-2 under 45 kg ha^{-1} and Kufri Chipsona-1 under 60 kg S ha^{-1} in descending order. Minimum gross income was recorded with variety Kufri Jyoti without sulphur application. Highest net income was obtained with variety Kufri Pushkar under 45 kg ha^{-1} sulphur followed by 60, 30, 15 kg ha^{-1} and without sulphur application with same variety. Minimum net income was received with Kufri Jyoti without sulphur application. Highest cost: benefit ratio was noted with Kufri Pushkar with 45 kg S ha^{-1} followed by 60 and 30 kg sulphur application with same variety. Lowest cost: benefit ratio was realized with Kufri Jyoti under control. The increase in yield with sulphur application under different varieties might be the reason for these results. Lalitha *et al.* (2000) also reported higher net return and cost: benefit ratio with sulphur application.

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