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Effect of Sulphur on the Yield and Quality of Potato Varieties in Tista Meander Floodplain Soil of Bangladesh

M. Waliur Rahman[1], Saiful Islam[2*], M. Monirul Islam[3] and M. Sazzad Hossain[4]

[1]Breeder Seed Production Center, Bangladesh Agricultural Research Institute, Debiganj, Panchagarh, Bangladesh.
[2]Advanced Seed Research and Biotech Centre, Gulshan, Dhaka, Bangladesh.
[3]Tuber Crops Research Center, Bangladesh Agricultural Research Institute, Gazipur, Bangladesh.
[4]Pulse Research and Regional Agricultural Research Station, Bangladesh Agricultural Research Institute, Ishwardi, Pabna, Bangladesh.

Authors' contributions

This work was carried out in collaboration among all authors. Author MWR conducted planning, field experiment and prepared final draft of the manuscript. Author SI supported with laboratory work, literature review and editing, Authors MMI designed and supervised the study and did final editing of the manuscript. Authors MSH helped in designing the study. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was carried out at Breeder seed Production Centre (BSPC), Debiganj, Panchagarh during the Rabi season of 2016-2017 to study the effect of five levels of sulphur application on yield and quality attributes of three potato varieties. The main objective of the experiment was to determine the effect of sulphur on the yield and quality of potato varieties. There were five treatments comprising different levels of sulphur such as T_1 (control-no sulphur), T_2 (75% RDS), T_3 (100% RDS), T_4 (125% RDS) and T_5 (150% RDS). Three BARI released potato variety; BARI Alu 36 (4.26 R), BARI Alu 40 (4.45W) and BARI Alu 25 (Asterix) were used in this experiment. The experiment was laid out in a randomized complete block design (RCBD) with three

**Corresponding author: E-mail: saif.uoda@yahoo.com;*

replications. The tuber yield and yield contributing characters were significantly influenced by the application of sulphur. Maximum tuber yield (39.28 t/ha) was recorded in BARI Alu 40 (4.45 w). Highest dry matter content, specific gravity and starch content were found in BARI Alu 40 (4.45 w), which was followed by BARI Alu 36 (4.26 R) in case of specific gravity and starch content. Sulphur application in potato varieties showed significant influence on tuber yield of potato. This parameter increased with increasing dose of sulphur up to 100% RDS. Thereafter, further increase in sulphur did not showed any remarkable influence. Besides, sulphur application in potato varieties showed significant influence on tuber quality of potato. The maximum dry matter yield and starch yield were recorded in the treatment T_3, which was followed by all other treatments except T_1. The minimum dry matter yield and starch yield were recorded in the treatment T_1. Combined effect showed insignificant influences between varieties and sulphur levels. BARI Alu 40 (4.45 w) was found superior over other varieties in terms of yield and quality attributes. Treatment T_3 (100% RDS) was found superior over other treatments in terms of yield.

Keywords: Potato variety; sulphur; tuber yield; starch; dry matter.

1. INTRODUCTION

Potato *(Solanum tuberosum L.)* belongs to the family Solanaceae and genus *Solanum* [1]. It is one of the major world food crops in its ability to produce high food per unit area per unit time [2]. Potato is an important cash crop in Bangladesh. It is also used as food and cash crop in the world. It can meet up vegetable demand and provide necessary nutrients for the people of the low income group [3,4]. Besides, it is consumed in different forms such as boiled or fried and many different processed products like chips, French fries, flakes, powder etc. The average yield of potato in Bangladesh is 19.55 t/ha; which is much below the crop potential productivity [5]. Genetical makeup has great influences on yield and quality of potato tubers. Various varieties of potato having wide variation in their yield potential and quality attributes have been evolved [6]. 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 [7,8]. Potato is the most sensitive crop to nutrient stress because of its sparse root system. Thus it needs high dose of fertilizers for getting full yield potential. Soil nutrient stress is the most significant factor controlling crop yield [9]. 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 [10]. Sulphur deficient plants had poor utilization of nitrogen, phosphorus and potash and a significant reduction of catalase activities at all age [11]. Intensive cropping and use of high-grade fertilizers have caused the depletion of sulphur in soils. Plants are deficit to sulphur in low organic matter, acidic condition, sandy in nature and highly leached soil [12]. Decrease in tuber dry matter yield, starch and essential amino acids particularly cystine and leucine were observed with sulphur deficiency [13,14]. 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 [15]. The need of application of sulphur along with its beneficial effects on yield and quality has been reported by earlier workers [16,17,18]. Hence, an experiment was conducted to determine the effect of sulphur on the yield and quality of potato varieties.

2. MATERIALS AND METHODS

2.1 Experimental Site and Soil Character-istics

The experiment was conducted at BSPC, Debiganj, Panchagarh under AEZ-3 (Tista Meander Floodplain soil) during the Rabi season of 2016-2017 to study the effect of sulphur rate and variety on the yield and quality of potato. The soil was moderately acidic (pH=5.70) in nature and very low organic matter content (0.90%). Total N content was (0.05%) and exchangeable K (0.24 meq per 100g). Phosphorus (P) and Iron (Fe) content of this soil is very high. Sulphar (s) content of this soil is very low. Boron (B), Zinc (Zn), Calcium (Ca) and Magnesium (Mg) were below the critical level. The chemical properties of initial soils of BSPC, Debiganj, Panchagarh have been shown in (Table 1).

Table 1. The chemical properties of initial soils of the experimental fields

Location	Soil texture	pH	O.M%	Ca	Mg	K	Total N%	P	S	B	Cu	Fe	Mn	Zn
				Meq/100 g				µg/ml						
BSPC, Debiganj	Sandy Loam	5.70	0.90	1.30	0.45	0.24	0.05	108.00	4.16	0.20	1.8	72	15	0.53
Critical level		-	-	2.0	0.5	0.12	-	7.0	10	0.2	0.2	4.0	1.0	0.6

BSPC= Breeder seed production center, O.M= Organic matter

2.2 Experimental Design, Treatments and Method of Fertilizer Application

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. There were five treatments comprising different levels of the sulphur T1 (Control- no sulphur), T2 (75% RDS), T3 (100% RDS), T4 (125% RDS), T5 (150% RDS). Fertilizers were used as a soil test basis except gypsum. Urea, TSP, MoP, Gypsum, Magnesium sulphate, Zinc sulphate and Boric acid were used as a source of N, P, K, S, Mg, Zn and B, respectively. Entire phosphorus, potassium, Sulphar, magnesium, zinc, boron and half of nitrogen were applied at the time of planting and mixed with soil. Remaining half of nitrogen was applied by the side of the row at 30 DAP (days after planting) followed by earthing up.

*RDS= Recommended dose of sulphur.

2.3 Planting, Harvesting and Intercultural Operation

Potato variety BARI Alu36 (4.26R), BARI Alu40 (4.45 W) and BARI Alu25 (Asterix) were used as a test crop. The unit plot size was 3 m×3 m. Healthy well sprouted and uniform size potato tubers were planted at the spacing of 60 cm x 25 cm on 28th November of 2016. Potato was harvested on 27th February of 2017. Intercultural operations and other agronomic practices were done as per requirement.

2.4 Soil Sampling and Chemical Analysis

After collection, soil samples were analyzed following standard laboratory method [19]. Core sampler method [20] and wet oxidation method [21] were used to determine the bulk density and organic carbon, respectively. Glass electrode pH meter (1:2.5) was used to determine soil pH. According to Page [19], 0.5 M $NaHCO_3$ (pH 8.5), NH_4OAc and $CaCl_2$ extraction procedures were used to determine the available P, exchangeable K and available S, respectively. The Kjeldahl method was used to determine the total N.

2.5 Data Collection

Data were taken on plant height (cm), foliage coverage, number of stem per hill, tuber per hill, weight of tuber per hill, tuber yield and dry matter, starch, specific gravity and senescence of potato plant. Plant height, foliage coverage and Stem per hill were assessed at 60 days after planting using green method [22].

2.6 Statistical Analysis

Data that were taken from the field experiment has been analyzed by MSTATC program and means separation was done by Duncan's Multiple Range Test (DMRT) [23]. One way ANOVA table was used to perform this analysis.

3. RESULTS AND DISCUSSION

3.1 Effects of Variety on the Tuber Yield and Yield Contributing Characters of Potato

Results revealed that yield and yield contributing characters of potato were significantly influenced by the variety (Table 2). The highest plant height (73.18 cm) was observed from BARI Alu 36 (4.26R) and the lowest was observed in BARI Alu 40 (4.45 W), which was followed by BARI Alu 25 (Asterix). Maximum foliage coverage, tuber per hill, tuber weight per hill and tuber yield of potato were found from BARI Alu40 (4.45 W) and the minimum was recorded in BARI Alu 36 (4.26 R), which was followed by BARI Alu25 (Asterix). In case of stem per hill maximum number of stem per hill was recorded in BARI ALu25 (Asterix) and the minimum was recorded in BARI Alu 36 (4.26 R), which was followed by BARI Alu40 (4.45 W). In case of yield components and tuber yield BARI Alu 40 was performed better than other two varieties. It might be accomplished that BARI Alu 40 would be a good variety in Tista Meander Floodplain Soil of Bangladesh. Kumar, et al. and Jaiswal et al. similar findings also reported significant variation in tuber yield of different potato varieties [24,25]. Bhardwaj and his team were also found significant difference among different genotypes for tuber yield [26].

3.2 Effect of Variety on Dry Matter, Starch, Specific Gravity and Senescence's of Potato

Results revealed that significant variation was observed among dry matter, starch, specific gravity and senescence's of potato due to varietals effect (Table 3). The Highest dry matter content, specific gravity and starch content were found in BARI Alu 40 (4.45 w), which was followed by BARI Alu36 (4.26 R) in case of specific gravity and starch content. The lowest

was recorded in BARI Alu 25 (Asterix). In case of senescence's%, the highest was found in BARI Alu 25 (Asterix) and the lowest was recorded in BARI Alu 40 (4.45 W). Again in case of tuber qualities, BARI Alu 40 was superior to other two varieties which indicated that BARI Alu 40 could be used as processing and table purpose potato variety with better storage ability. Jaiswal and team were also reported differences in quality parameters among different varieties of potato [24,27].

3.3 Effect of Sulphur Dose on the Tuber Yield and Yield Contributing Characters of Potato

Results revealed that significant variation were observed among plant height, foliage coverage, tuber weight per hill and tuber yield of potato. On the other hand there was no significant variation between stem per hill and tuber per hill due to application of different doses sulphur (Table 4). The highest plant height was observed in T_3 (100% RDS), which was statistically identical to T_2, T_4 and T_5 treatments. The lowest plant height was observed in T_1 (control-no sulphur). Maximum foliage coverage was found in T_4 (125% RDS) treatment, which was statistically identical to T_3 and T_5. Minimum foliage coverage was found in T_1 treatment. The highest tuber weight per hill and tuber yield of potato were recorded in T_3 (100% RDS), which was statistically identical to all other treatments except T_1. The lowest weights of tubers per hill and tuber yield of potato were recorded in the treatment T_1 (control-no sulphur). Improvement in tuber yield was not observed with 125% RDS and 150% RDS application. 100% RDS (T_3)

Table 2. Effect of variety on the tuber yield and yield contributing characters of potato

Variety	Plant height (cm)	Foliage coverage (%)	Stem/hill (No.)	Tuber/hill (No)	Tuber weight/hill (Kg)	Tuber yield (t/ha)
BARI Alu 36 (4.26 R)	73.18 a	80.20 b	7.30 b	10.32 b	0.51 b	33.98 b
BARI Alu 40 (4.45 W)	66.56 b	89.33 a	8.33 b	13.26 a	0.59 a	39.28 a
BARI Alu 25 (Asterix)	67.02 b	82.53 b	9.76 a	11.45 b	0.52 b	34.78 b
CV%	6.52	4.41	16.47	19.15	7.02	6.84

Means followed by the same or no letter in the same column do not differ significantly each other at 5% level of DMRT

Table 3. Effect of variety on the dry matter, starch, specific gravity and senescence's of potato

Variety	Dry matter (%)	Starch (%)	Specific gravity	Senescence's % at 90 DAP
BARI Alu 36 (4.26 R)	21.25 b	16.09 a	1.088 ab	81.53 b
BARI Alu 40 (4.45 W)	22.20 a	16.99 a	1.092 a	77.86 c
BARI Alu 25 (Asterix)	20.05 c	14.88 b	1.082 b	94.13 a
CV%	5.94	7.68	0.56	3.95

Means followed by the same or no letter in the same column do not differ significantly each other at 5% level of DMRT

Table 4. Effect of sulphur dose on the tuber yield and yield contributing characters of potato

Treatment	Plant height (cm)	Foliage coverage (%)	Stem/hill (No.)	Tuber/hill (No)	Tuber weight /hill (Kg)	Tuber yield (t/ha)
T_1	49.73 b	62.77 c	8.80	11.16	0.37 b	25.16 b
T_2	73.57 a	86.55 b	8.24	12.47	0.58 a	38.05 a
T_3	74.04 a	88.55 ab	8.38	11.86	0.60 a	40.07 a
T_4	74.00 a	92.00 a	8.97	11.71	0.57 a	38.39 a
T_5	73.26 a	90.22 ab	7.93	11.17	0.58 a	38.40 a
CV%	6.52	4.41	16.47	19.15	7.02	6.84

Means followed by the same or no letter in the same column do not differ significantly each other at 5% level of DMRT

Table 5. Effect of sulphur dose on dry matter, starch, specific gravity, and senescence's of potato

Treatment	Dry matter (%)	Dry matter yield (t/ha)	Starch (%)	Starch yield (t/ha)	Specific gravity	Senescence's % at 90 DAP
T_1	22.28 a	5.62 b	17.06 a	4.30 b	1.093	94.00 a
T_2	21.17 ab	8.07 a	16.03 ab	6.10 a	1.088	82.88 b
T_3	21.21 ab	8.51 a	16.05 ab	6.42 a	1.088	84.77 b
T_4	20.81 b	8.04 a	15.63 b	6.04 a	1.086	78.00 c
T_5	20.37 b	7.83 a	15.21 b	5.96 a	1.084	82.88 b
CV%	5.94	9.13	7.68	11.03	0.56	3.95

DAP= Days after planting

Means followed by the same or no letter in the same column do not differ significantly each other at 5% level of DMRT

application was observed higher result in all three varieties. Farmers could apply this dose of sulpur in potato growing field. On the other hand, heavy applications of sulphur can result in yield reductions [28].

3.4 Effect of Sulphur Doses on Dry Matter, Starch, Specific Gravity and Senescence's of Potato

Results revealed that significant variations were observed among dry matter, starch, and senescence's of potato due to application of different dose of sulphur. On the other hand, there was no significant difference in specific gravity of tubers (Table 5). The highest dry matter%, and starch% were recorded in T_1 (control-no sulphur), which was followed by T_2 and T_3 treatment. After that these parameters decreased with increasing dose of sulphur. On the other hand, maximum dry matter yield and starch yield were recorded in the treatment T_3, which was followed by all other treatments except T_1. The minimum dry matter yield and starch yield were recorded in the treatment T1. In case of senescence's of potato, maximum was recorded in T_1 treatment. The minimum was recorded in T_4 treatment.

3.5 Combined Effect of Variety and Sulphur Levels

Combined effect showed insignificant influences between varieties and sulphur levels.

4. CONCLUSION

From the above discussion it may be concluded that, BARI Alu 40 (4.45 w) was found superior over other varieties in terms of yield and quality attributes. Treatment T_3 (100% RDS) was found superior over other treatments in terms of yield. Combined effect showed in-significant influences between varieties and sulphur levels.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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