Journal of Ecological Engineering
Volume 14, No. 4, Oct. 2013, pp. 45–49
DOI: 10.5604/2081139X.1066234

Research Article

PERFORMANCE OF ONE POTATO PLANT AS INFLUENCED BY SOIL CONDITIONER UGMAX

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Received: 2013.08.19
Accepted: 2013.09.08
Published: 2013.10.10

ABSTRACT

Studies were carried out over the years 2008-2010 to determine the effect of Soil Conditioner UGmax on unit performance, that is potato tuber weight and number per one plant and average weight of one tuber. An experiment included two factors: I – two edible potato cultivars (Satina and Tajfun), II – five UGmax application methods (1. control without UGmax, 2. UGmax applied prior to tuber planting at the rate of 1.0 dm^3 ha^{-1}, 3. UGmax applied prior to tuber planting at the rate of 0.5 dm^3 ha^{-1} followed by two foliar applications at the rate of 0.25 dm^3 ha^{-1}, 4. UGmax applied prior to tuber planting at the rate of 1,0 dm^3 ha^{-1} followed by two foliar applications at the rate of 0.5 dm^3 ha^{-1}, 5. two foliar applications of UGmax at the rate of 0.5 dm^3 ha^{-1}). Samples, consisting of tubers of 10 potato plants, were taken to determine the performance of one plant. The Soil Fertilise UGmax increased the weight of tubers per plant and the average weight of one tuber compared with the control. Moreover, the potato cultivars and weather conditions during the growing season significantly influenced the above-mentioned parameters.

Keywords: cultivars, individual productivity, potato, soil fertilizer UGmax.

INTRODUCTION

Intensification of agriculture needs various solutions to improve physical and chemical soil properties [1, 5], increasing plant resistance to biotic and abiotic stresses [11, 15] and, as a result, obtaining higher yields of better quality [10, 12, 13]. Recently, an application of stimulants, bacterial inoculants, effective micro-organisms and soil conditioners in plant production have been gaining popularity [8, 14, 17]. As there is a paucity of studies on the effect of the Soil Conditioner UGmax on potato quantitative and qualitative characteristics, it has been attempted to determine the effect of UGmax on potato unit performance, that is tuber weight and number per one plant and average weight of one tuber.

MATERIALS AND METHODS

Potato tubers were obtained from a field experiment set up on a soil belonging to a very good rye complex of soil quality, at the Zawady Experimental Station of Siedlce University of Natural Sciences and Humanities. Selected chemical soil properties prior to the experiment set-up are presented in Table 1. The experiment was arranged as a split-plot design with three replicates and involved two factors: factor I – two medium-early edible potato cultivars Satina and Tajfun, and factor II – five methods of Soil Conditioner UGmax application including different timing and rates (Table 2). The composition of fertilizers is given in Table 3. In autumn, farmyard manure was applied at a rate of 25.0 t ha^{-1} in addition to mineral fertilizers used at the following rates: 44.0 kg

Table 1. Chemical composition of soil in the experiment

Years	pH in KCl	Humus [g·kg^{-1}]	Content of assimilable components [mg·kg^{-1} of soil]		
			P	K	Mg
2008	4.99	15.4	90.64	124.5	41.00
2009	4.81	16.8	76.12	174.3	34.00
2010	5.91	18.10	73.48	112.1	45.00

Table 2. Methodological data

Treatments	Rates [dm^3·ha^{-1}]	UGmax application time		
		before tuber planting	at 10–15 cm plant height	at start of flowering
1. Control – without UGmax	–	–	–	–
2. Soil application before planting	1.0	1.0	–	–
3. Soil application before planting and 2 foliar applications	1.0	0.5	0.25	0.25
4. Soil application before planting and 2 foliar applications	2.0	1.0	0.5	0.5
5. 2 foliar applications	1.0	–	0.5	0.5

Table 3. Composition of the microbiological fertilizer used in the experiment

Content of macro- and microelements [mg·dm^{-3}]						Micro-organisms
N	P	K	Mg	Na	Mn	Lactic acid bacteria, photosynthetic bacteria, *Azotobacter*, *Pseudomonas*, yeast, actinomycetes
1200	220	2905	100	200	0.3	

ha^{-1} P (in the form of 46% triple superphosphate), 124.5 kg ha^{-1} K (in the form of 60% potassium salt) and 100 kg N per 1 ha (in the form of 34% ammonium saltpeter), nitrogen applied in spring. Potato tubers were planted by hand in mid-April at a row spacing of 67 × 37 cm, and harvested in early September. The individual productivity of potato plants were analysed in the experiment (tuber mass per plant, tuber number per plant, mean mass of tuber). The results were statistically analysed using variance analysis and the Tukey's least significant difference was calculated. The climatic conditions during the potato vegetation are presented in Table 4.

RESULTS AND DISCUSSION

Potato tuber yield per unit area is mainly determined by unit performance, that is tuber weight per one plant, tuber number per one plant and average weight of one tuber [4]. In the experiment described here, the average tuber weight per one *Solanum tuberosum* plant was 1311.8 g and ranged from 903.4 to 1916.7 g (Table 5). Similar results have been reported by Kraska and Pałys [6] after an application of intensive fertilisation and control measures. The tuber weight per one plant depended on the method of UGmax application, cultivar and weather conditions over the study years. Higher tuber weight was determined in all UGmax-treated plots, compared with the control, the average difference being 221.9 g. Moreover, higher tuber weight per one plant was recorded for Tajfun versus Satina. The effect of cultivar on this parameter has been confirmed by Gugała and Zarzecka [2] as well as Krzysztofik et al. [7]. What is more, an interaction of cultivars with study years and UGmax application methods with study years was found in the present study. The highest tuber weight was determined in 2008 when the temperature followed the multi-year pattern whereas precipitation, although higher, was evenly distributed. By contrast, the lowest tuber weight was recorded in 2009 which was characterised by unevenly distributed precipitation. Compared with the remaining study years, the effect of UGmax was more pronounced in 2008 when also tuber weight per one plant was by 273.7 g higher than the control, where no UGmax had been applied. Also Kołodziejczyk [4] demonstrated that potato yields per one plant differed under changeable weather conditions, the differences exceeding 100% when the weather was most unstable. The greatest tuber weight in each study year was recorded in the plots which

Table 4. Weather conditions over the potato growing season in 2008–2010 (Zawady Meteorological Station)

Years	Months						
	IV	V	VI	VII	VIII	IX	IV–IX
Rainfall [mm]							
2008	28.2	85.6	49.0	69.8	75.4	63.4	371.4
2009	8.1	68.9	145.2	26.4	80.9	24.9	354.4
2010	10.7	93.2	62.6	77.0	106.3	109.9	459.7
Mean long-term sum (1987–2000)	38.6	44.1	52.4	49.8	43.0	47.3	275.2
Air temperature [°C]							
2008	9.1	12.7	17.4	18.4	18.5	12.2	14.7
2009	10.3	12.9	15.7	19.4	17.7	14.6	15.1
2010	8.9	14.0	17.4	21.6	19.8	11.8	15.6
Mean long-term sum (1987–2000)	7.8	12.5	17.2	19.2	18.5	13.1	14.7

Table 5. Tuber weight per potato plant [g]

Treatments*	Cultivars		Years			Mean
	Satina	Tajfun	2008	2009	2010	
1	1000.0	1268.2	1461.7	903.4	1037.4	1134.2
2	1132.1	1486.9	1665.0	993.4	1270.2	1309.5
3	1213.3	1600.0	1793.3	1121.7	1305.0	1406.7
4	1327.9	1632.2	1916.7	1186.7	1336.8	1480.1
5	1080.0	1376.6	1566.7	915.0	1203.3	1228.3
Means	1150.6	1472.8	1680.7	1024.0	1230.6	1311.8
Means for treatments 2–5	1188.3	1523.9	1735.4	1054.2	1278.8	1356.1

Comments: $LSD_{0.05}$ between: cultivars (I) = 43.3, UGmax application methods (II) = 126.5, years (III) = 66.5, interaction I × II = n.s., interaction I × III = 226.1, interaction II × III = 119.1

Explanations: n.s. – non-significant differences; * – see Table 2.

received foliar applications of UGmax at the overall rate of 2.0 $dm^3 \cdot ha^{-1}$.

Tuber number per one plant did not depend on the experimental factors or weather conditions during the growing season but the cultivars interacted with study years (Table 6). Similar findings have been reported by Rychcik et al. [9] whereas according to Kraska et al Pałys [6] intensive fertilisation and control measures increased tuber number per plant compared to the control. Gugała et al. [2009] demonstrated that an application of herbicides was followed by lower tuber number per plant and higher tuber weight per plant.

The average weight of one tuber was influenced by Soil Conditioner UGmax, cultivars and weather conditions during the growing seasons (Table 7). Soil application of UGmax (2) as well as soil and foliar applications (3, 4) of UGmax significantly increased the average weight of one tuber compared with the control (1). Furthermore, tubers produced by Tajfun were heavier compared with Satina. Differences between cultivars have been reported by other authors [4, 7, 2] too. The average weight of one tuber was significantly higher in 2008 than in 2009 or 2010. The effect of weather conditions on this parameter has also been reported by Kraska and Pałys [6], Rychcik et all. [9] and Gugała et al. [3]. Potato cultivars interacted with UGmax application methods and study years, and UGmax application methods interacted with study years. In all the study years, three applications of UGmax at the rate of 2.0 $dm^3 \cdot ha^{-1}$ (4) was the most favourable way of theS application of this conditioner

The total tuber yield, described in the work by Zarzecka and Gugała [16], significantly correlated with tuber weight per one plant as well as average weight of one tuber (tab. 8). The values of correlation coefficients were high and similar, which confirms that potato yield is affected by unit performance characteristics. Similar relationships have been reported by Krzysztofik et al. [7].

Table 6. Tuber number per potato plant

Treatments*	Cultivars		Years			Mean
	Satina	Tajfun	2008	2009	2010	
1.	13.44	13.24	13.97	14.07	12.00	13.45
2.	11.64	11.44	12.10	11.77	10.77	11.55
3.	11.27	11.71	12.37	11.70	10.40	11.49
4.	11.07	10.35	10.67	11.60	9.85	10.71
5.	12.33	12.18	12.44	12.27	12.07	12.26
Means	11.95	11.78	12.31	12.28	11.02	11.87
Means for treatments 2–5	11.58	11.42	11.90	11.84	10.77	11.50

Comments: $LSD_{0.05}$ between: cultivars (I) = n.s., UGmax application methods (II) = n.s., years (III) = n.s., interaction I × II = n.s., interaction I × III = 3.80, interaction II × III = n.s.

Explanations: n.s. – non-significant differences; * – see Table 2.

Table 7. Average weight of one potato tuber [g]

Treatments *	Cultivars		Years			Mean
	Satina	Tajfun	2008	2009	2010	
1.	77.68	98.96	110.51	67.67	86.79	88.32
2.	98.97	129.85	139.61	85.00	118.62	114.41
3.	109.42	136.28	144.81	97.59	126.17	122.86
4.	121.49	162.06	185.00	103.95	136.39	141.78
5.	89.01	114.27	129.58	75.95	99.40	101.64
Means	99.32	128.29	141.9	86.03	113.47	113.80
Means for treatments 2–5	104.72	135.62	149.80	90.62	120.10	120.17

Comments: $LSD_{0.05}$ between: cultivars (I) = 9.93, UGmax application methods (II) = 16.64, years (III) = 15.20, interaction I × II = 16.62, interaction I × III = 358.05, interaction II × III = 28.83.

Explanations: * – see Table 2.

Table 8. Statistically significant dependencies between total tuber yield and individual parameters of potato performance

Parameters		Correlation coefficients
Total potato yield [t·ha^{-1}]	Tuber weight per plant [g]	0.847*
	Average weight of one tuber [g]	0.816*

Explanations: * – significant at p = 0.05.

CONCLUSION

1. Potato tuber weight per one plant and average weight of one tuber were significantly influenced by application methods of the Soil Conditioner UGmax, cultivars and weather conditions during the growing season.
2. Three applications of Soil Conditioner UGmax, prior to tuber planting and two foliar sprayings, seemed to be the best method of application.
3. Higher tuber weight per one plant and average weight of one tuber were produced by Tajfun than Satina.

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