Plant Archives Vol. 18 No. 2, 2018 pp. 2207-2212 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

THE IMPACT OF FOLIAR APPLICATION OF NANAOFERTILIZER, SEAWEED AND HYPERTONIC ON YIELD OF POTATO

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Abstract

A field experiment was conducted in autumn season 2017 at College of Agriculture, University of Qadisiyah, research field to investigate the effect of foliar application of SMP nan/o-fertilizes, SW seaweed ibanad multi and HP growth regulator hypertonic on growth and yield of potato. Treatments included 4 levels (25, 50, 75 and 100 g nano fertilizer 100 L^{-1} water foliar applied , 1 kg naonfertilizers ha^{-1}(as recommended) dissolved in 400 liters of solution ha-1. The experiment included single , di, tri combinations, in addition to control (water only) using RCBD with 3 replicates . Growth and yield parameters tested were chlorophyll, dry matter yield of vegetative part ,fresh tubers yield, biological yield ,harvest index and % of starch, crude protein ,ascorbic acid and water use efficiency (WUE). Results indicated that (SMP+SW+HP) applied treatment was significantly higher followed by the di and single spray combinations, in yield of fresh , dry tubers , vegetative yield and biological yield giving 32.76, 7.280, 2.194 and 10.110 Mg ha^{-1}) respectively , compared with the control (18.86, 3.626, 1.174, and 5.258 Mg ha^{-1}), respectively. The highest % of Starch, Crude Protein and ascorbic acid (vitamin c) (16.74 %,9.2 and 1.463%) were with tri spry (SMP+SW+HP) than other treatments.

Key words : Crude protein, starch, ascorbic acid, drip irrigation, SMP nanofertilizer, arizona cultivar, multi iband sea weed.

Introduction

Potatoes (*Solanum tuberosum* L.) are one of the most important food and leading vegetable crop for human . Potato production ranks fourth in the world after rice, wheat, and maize (Faostat, 2013). Therefore, careful nutritional management is very important to get the optimum yield. In arid and semiarid regions, low organic matter and low fertility are of great concern. In these regions, low yield is partly due to the following factors: a) high nutrient turnover in soil-plant system coupled with low and imbalanced fertilizer use, b) deficiencies of micro and some macronutrients, c) soil degradation due to desertification, salinization and alkalization as well as erosion, d) wide nutrient gap between nutrient demand and supply, and e) low fertilizer and water use efficiencies (Rao and Reddy, 2010; Rayan *et al*., 2012; Al-Taey *et al*., 2015; Al-Taey, 2017). Soils of these areas often have low to medium available phosphorus (P), medium to high potassium (K), low iron (Fe), manganese (Mn) and zinc (Zn) (Sillanpaa, 1990). Therefore, nutrient management is one of the important approaches in achieving high productivity of potato in this region (Moinuddin *et al*., 2017; AL-Taey and Majid, 2018). Nanotechnology is a new area of technology in agricultural fields that recently has emerged and could be very useful in designing the new generation of fertilizers with higher efficiency of nutrient use. Nano-fertilizer technology is very innovative and has the potential to revolutionize the agricultural systems. Nanofertilizers are nano-structured formulation of fertilizers that release nutrients into the soil gradually and in a controlled way (Rameshaiah and Jpallavi, 2015; Morales-Díaz *et al*., 2017). Nano-structured fertilizer exhibits novel physico-chemical properties, so that they can satisfy plant root demand more efficiently in comparison with conventional fertilizers (in the form of salts). The controlled release of the nutrient could be through the process of dissolution and ion exchange reactions (Jyothi and Hebsur, 2017; Ali and Al-Juthery, 2017). Nano-sized active ingredients in nano-structured fertilizer may help to improve nutrient use efficiency and this could be due to their high specific surface area (between 1 to 100 nm), which facilitates good absorption of the nutrients (Singh *et al*., 2017).

Growth regulators stimulate plants' life processes, thus improving the quality and amount of plant yields (Wierzbowska *et al*., 2015). In potato, besides the positive effect on yield of tubers, It can enhance the potato's resistance to adverse environmental conditions (Janmohammadi *et al*., 2016).

Bio-stimulants, such as ascorbic acid and Atonik may be of natural or synthetic origins consist of various organic and/ or inorganic components having positive effect on plant vital processes (Calvo *et al*., 2014). Algae Extracts can be consider as cheap source of natural growth stimulators and other bioactive substances (Panda *et al*., 2012). Hypertonic is a synthetic bio-stimulant composed of three phenolic compounds stimulates plant growth without causing malformation or toxicity as well as accelerates the plasma streaming of the cells by increasing the endogenous auxin level (Przybysz *et al*., 2014). Hypertonic can affect the yield of tubers, improve their biochemical parameters and enhance the potato's resistance to adverse environmental conditions or pathogens (Sawicka *et al*., 2011 and Wierzbowska *et al*., 2015). The requirement of amino acids in essential quantities is well known as a means to increase yield and overall quality of corps (Fawzy *et al*., 2010; Gouda *et al*., 2015; Doaa *et al*., 2015). Folic acid is essential biochemical functions in amino acid metabolism and nucleic acid synthesis (Andrew *et al*., 2000; Raeisi *et al*., 2017). Ibrahim *et al*. (2015) found that folic acid significantly improved some potato growth parameters.

The aim of this research was to determine the effect foliar application of bio-stimulators and nano fertilizer on growth, yield and selected chemical properties of potato tubers.

Materials and Methods

Field experiment was carried out during autumn season of 2017 at one of the Agriculture Research Fields, College of Agriculture, University of Al-Qadisiyah in Loamy Sand soil (table 1), to study the response of potato (*Solanum tuberosum* L.) to foliar applied nano fertilizers, Seaweed extract and Plant growth regulator (Hypertonic) either separately (each alone) or in combination of 2 or 3 in randomized complete block design (RCBD) experiment with three replications. The nanofertilizer was chelated macro and micro nutrients (Super Micro Plus (SMP)) (a complex of 11 essential elements (N 5%, P 4%, K 2%, Mg 1% Ca 1.5%, Fe 4% Cu 1%, Zn 5%, Mn 2% Mo 0.04% and B 0.06%). Liquid seaweed fertilizer (IBANAD MOLTI (SW)) contained organic matter 43%, free amino acids 5% with pH 3.4.

Plant growth regulator (Hypertonic) HP contained potassium ortho-nitro phenolate, potassium para-nitro phenolate and natural organic acid.

Field land was plowed by the rotary plow and divided to blocks and experimental units (1.5 m in width (two rows with 0.75m apart)) and 3 m in length). The experiment was irrigated through Drip irrigation system using fresh river water.

Potato tubers (*Solanum tuberosum* L.) Arizona cultivar was planted at 20-9-2017, at a depth of 15 cm and 20 cm apart. After 30 days after planting (DAP) 1st foliar combination application was conducted. 2nd, 3rd, and 4th foliar applications were performed in 7 day

Table 1 : Some soil properties.

References	Value	Property
Salim and Ali (2017), Landon (1984)	Particle size distribution (gm kg^{-1}soil)	
	50200750	ClaySiltSand
	Loamy Sand	Texture
	19.4	CEC Cmol$_c$ kg^{-1}Soil
	11.0	OM gm kg^{-1}Soil
	173	Total carbonates gm kg^{-1}Soil
	7.6	pH
	2.9	EC(1:1) (dS m^{-1})
	2014197	Available macronutrients (mg kg^{-1}soil)NPK
	1.31	Bulk density Mg m^{-3}

Table 2 : Treatments.

Dates and rates of foliar applied treatment combinations				Treatments	
48DAP	41DAP	37DAP	30DAP		
0	0	0	0	Control	T1
35	30	25	20	Hypertonic (HP)	T2
200	150	100	50	Seaweed (SW)	T3
100	75	50	25	Nano SMP (NSMP)	T4
35+200	30+150	25+100	20+50	(HP) + (SW)	T5
35+100	30+75	25+50	20+25	(HP) + (NSMP)	T6
200+100	150+75	100+50	50+25	(SW) + (NSMP)	T7
200+100+35	150+75+30	100+50+25	50+25+20	(SW)+ (NSMP)+ (HP)	T8

Concentrations were : 25, 50, 75 and 100 g of SMP nano fertilizer; 20, 25, 30 and 35ml of hypertonic HP and 50, 100, 150 and 200 ml of seaweed dissolved in 100 L^{-1} water.

Table 3 :. The Effect of foliar application of treatments some potato parameters.

Biological yield (Mg ha^{-1})	Tubers yield (Dry Wt) (Mg ha^{-1})	% dry matter of tubers	Dry yield of vegetative part (Mg ha^{-1})	Tubers yield (Fresh wt) (Mg ha^{-1})	Chlorophyll SPAD	Tr. No.
5.258 g	3.626 f	19.22 c	1.174 g	18.86 f	33.20 d	T_1
6.111 f	4.317 e	19.34 c	1.310 f	22.32 e	35.07 cd	T_2
6.558 e	4.537 e	19.44 c	1.486 e	23.33 e	35.80 bcd	T_3
7.322 d	5.140 d	20.00 b	1.628 d	25.67d	37.60 bc	T_4
7.445 d	5.058 d	19.56 bc	1.808 c	25.86 d	37.90 bc	T_5
8.700 c	6.220 c	21.87 a	1.907bc	28.44 c	38.50 bc	T_6
9.224 b	6.673 b	21.93 a	1.962 b	30.45b	39.60 b	T_7
10.110a	7.280 a	22.22 a	2.194 a	32.76 a	43.70 a	T_8

intervals after the 1st application.

At the stage of tubers maturity some parameters of growth and yield were estimated. Total chlorophyll in the youngest expanded leaves was recorded using SPAD-502 Chlorophyll Meter (Minolta Camera Co. Ltd., Japan). Dry matter yield of vegetative parts was estimated for 10 plants and dry mater of tubers yield were measured according to A.O.A.C, (2000), after oven drying at 70^{0}C for 24 h. Starch was determined using a polarimetric method (Liutskanov *et al.*, 1994). Vitamin C was evaluated according to Ivanov and Popov (1994) method. Total nitrogen was determined by Kjeldal's method and crude protein obtained from (%N × 6.25) (Tomov *et al.*, 2009). Harvest index was determined from the ratio of tubers dry weight to dry weight of whole plant (shoot+ root). Water use efficiency (WUE) or water productivity was calculated as the ratio of potato yield (Y) to total crop water use (WU) (Howell, 2000). Statistical analysis of collected data was performed by Duncan's multiple range test at $p \leq 0.05$ (1955) after analyzing the data by Genstat program.

Results

Foliar application of treatments with different combinations achieved significant effect on the content of chlorophyll. The highest content was achieved in the tertiary combination (SMP+SW+HP) giving 43.70 compared to 33.20 SPAD for control (table 3). Fresh tuber weight yield was significantly higher with 32.76 Mg ha^{-1}, at (SMP+SW+HP) treatment compared to other treatments (table 3). The treatment (SMP + SW + HP) (T8) recorded the highest % of tuber dry matter (22.22 %). This treatment did not differ significantly than T5, T6 and T7 (table 3). This means that all combinations gave better result in this parameter than applying each treatment alone.

Tubers yield (dry wt.) was superior with T8 (SMP+ SW+HP) treatment giving 7.28 Mg ha^{-1} compared to other treatments especially with the control (3.626 Mg ha^{-1}) (table 3). The same trend was observed with yield of vegetative parts and biological yield (table 3).

Table 4 shows the results of treatments effect on

Table 4 : Effects of foliar application of treatments on some potato quality parameters and WUE.

WUE (Kg m^{-3})	Harvest index (%)	Ascorbic acid (mg kg^{-1} f.w.)	Starch (% f.w.)	Crude protein (% f.w.)	N (% tuber dry wt.)	Tr. No.
10.36 f	68.94 bc	122.9 f	11.10 f	7.8 e	1.248 e	T_1
12.27 e	70.63 ab	126.8 ef	11.21 f	8.1 de	1.296 de	T_2
12.82 e	69.17 bc	130.5 de	11.42 f	8.3 cd	1.328 cd	T_3
14.11 d	70.14 abc	133.4 cd	12.00 e	8.6 bc	1.376 bc	T_4
14.21 d	67.94 c	135.7 bcd	13.02 d	8.6 bc	1.376 bc	T_5
15.63 c	71.49 ab	138.9 bc	14.42 c	8.8 b	1.408 b	T_6
16.73 b	72.34 a	140.4 b	15.08 b	8.9 ab	1.424 ab	T_7
18.00 a	72.01 a	146.3 a	16.74 a	9.2 a	1.472 a	T_8

some tuber quality indices and WUE. The treatment of (NSMP+ SW+HP) was superior in N% and protein % starch, ascorbic acid harvest index and WUE, than other treatments.

Discussion

This study showed that foliar application of complete combination of nanofertilizer, seaweed extract and plant growth regulators (hypertonic), considerably improves growth ,tuber yield ,some quality parameters and WUE . It may suggest that the soil of the studied area has some of shortage in nutrient availability (table 1). From table 1, one can see that N, P and K concentrations were at medium level with low organic Carbone and alkaline pH (Ali, 2012). Besides, calcareous soil always lack of micronutrients especially Zn and Fe (Sillanpaa, 1990). Micronutrients is crucial for achieving higher yields (Marschner, 2011). The presence of all applied treatments (Macro and micronutrients) as nanofertilizer in combination and integration with seaweed extract as source of organic materials and growth regulators can be the reason for improvement on potato yield and it's components (Przybysz *et al*., 2014; Ali and Al-Kalil, 2015; Ali and Al-Jutheri, 2015 and Al-Juthery and Saadoun, 2018). Kowalczyk and Zielony (2008) stated that amino acids are known as building blocks proteins in plants beside number of additional functions in the regulating of metabolism. This is confirmed by El-Zohiri and Asfour (2009) on potato that was foliar applied with amino acids. Organic acids which are included in our treatments considered nowadays as black gold and for sure their presence will insure very good yield (Russo and Berlyn, 1990; Taha, 2011; Abu-Zinada and Sekh-Eleid, 2015 and Ali and Shaker, 2018). Treatments applied can prevent plant from different biotic and abiotic stresses and consequently improve yield (quantity and quality) (Singh *et al*., 2017; Khan *et al*., 2017). In consequence. from above results we can conclude the importance of integral application of mineral, organic and growth regulator application on growth and yield of potato and WUE. The very nice results with nanofertilizer applied in very low rate can open the door for more investigations in this field.

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