Research Article

Onion (*Allium cepa* L.) yield and phosphorus use efficiency as affected by plant extracted humic acid application

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Abstract

To study the effect of plant derived Humic acid (HA) on the nutrient use efficiency and yield of onion a pot experiment was conducted in a greenhouse of Land Resources Research Institute, National Agricultural Research Centre Islamabad, during year 2013. The experiment was laid out in Complete randomized design with two factor i.e. HA (150 mL 5 kg⁻¹ and 300 mL 5 kg⁻¹) and Phosphorus (P) levels (60 kg ha⁻¹ P₂O₅ (75 %) and 80 kg ha⁻¹ P₂O₅ (100 %)). Soil application of plant derived HA @ 300 mL 5 kg⁻¹ along with 80 kg ha⁻¹ P₂O₅ as Di-ammonium Phosphate (DAP) recorded the highest onion yield of 13.47 t ha⁻¹. However it was statistically at par with the treatment receiving 75% (60 kg ha⁻¹) P application along with plant derived HA @ 150 mL 5 kg⁻¹ soil. Secondly soil application of plant derived HA @ 300 mL 5 kg⁻¹ along with 80 kg ha⁻¹ P₂O₅ showed highest content of P (0.22%) in onion plant at maturity whereby HA @ 150 mL 5 kg⁻¹ along with 60 kg ha⁻¹ P₂O₅ (75% RDF) registered highest content of N (4.1%). It may concluded from the result of the experiments that HA applied @ 300 mL 5 kg⁻¹ integrated with Phosphatic fertilizers gave promising result and may be recommended for enhancing the onion yield and P and N concentration of soil.

Keywords: Humic acid; Onion; Phosphorus; Nutrient concentrations; Yield

Introduction

Onion (*Allium cepa* L.) belongs to the family Amaryllidaceae which is one of the most important monocotyledonous crops. It is a cross pollinated and cool season vegetable crop. It is widely used and most important vegetable which is grown in temperate and tropical regions of the world. In Pakistan, the total production of onion is 1.7 million tons

and grown on an area 129 thousand hectares. The pungency of the onion bulbs is due to the presence of a volatile oil that is allylpropyl disulfide [1]. One of the advantages of onion is that the bulbs can be harvested and sold either 'green' in salads [2], while the mature bulbs are cooked or eaten raw as a vegetable [3].

Humic acid is an organically charged bio-stimulant that significantly affects plant growth and development and increases crop yield. It has been extensively investigated that humic acid improves physical, chemical and biological properties of soils [4, 5]. The role of humic acid is well known in controlling, soil-borne diseases and improving soil health and nutrient uptake by plants, mineral availability, fruit quality and others [6]. Humic acid based fertilizers increase crop yield, stimulate plant enzymes/hormones and improve soil fertility in an ecologically and environmentally friendly manner [7, 8]. Several researchers highlighted the positive benefits of humic acid application on higher plants [9]. Humic acids also reduce toxic effects of salts on monocots [10] and dicots [11].

Enhanced nutrient uptake by plants as a result of humic acid application is also well established [12]. Likewise, the increased yield is also observed in many crops due to humic acid application, including potato [13], tomato, onions and other leafy vegetables [14].

Humic substances promote plant growth both directly and indirectly [15]. Indirectly they improves plant growth by improving soil properties such as aggregation, aeration, permeability, water holding capacity, drainage, prevent soil leaching, aids in root formation, hormonal activity, microbial growth, organic matter (OM) mineralization, Suppress diseases, increase solubilization and availability of microelements (e.g., Fe, Zn and Mn) and some macro elements (e.g., K, Ca, and P) [16]. However, there has been a lot of work cited on soil application of lignite derived humic acid but a little attention has been paid on application of plant extracted humic acid. Thus, this study was planned to assess the effect of plant extracted humic acid on nutrients use efficiency in onion.

Materials and methods

A pot experiment was carried out in a greenhouse of Land Resources research Institute, National Agricultural research Centre Islamabad to investigate the effect of plant extracted humic acid on nutrients use efficiency in onion. All pots were filled with five kilogram of clay loam soil after sieving. The basic characteristics are mentioned in (Table 1). Two onion plants were transferred to each pot and then the plant extracted humic acid and fertilizer were applied to each pot. There were 6 treatments ($T_1 = HA_0 + 75\% F$, $T_2 = HA_0 + 100\% F$, $T_3 = HA_{150ml} + 75\% F$, $T_4 = HA_{150ml} + 100\% F$, $T_5 = HA_{300ml} + 75\% F$ and $T_6 = HA_{300ml} + 100\% F$) replicated 3 times. The experiment was laid in Complete Randomized design with two factors. Factor 1 is the fertilizer levels (75% and 100%) of the recommended doses of N and P fertilizers (Urea and DAP) and factor 2 was the humic acid (HA @ 150 ml 5 kg⁻¹ and 300 ml 5 kg⁻¹). The composite sample was collected and analysed for various physic – chemical characteristics of soil [17]. Nitrate nitrogen, extractable Phosphorus and extractable potassium were carried out by AB – DTPA method [18]. The plant tissues analysis was carried out by wet digestion and phosphorus content by using spectrophotometer at 410 nm [17]. Potassium was determined by Flame photometer.

Results and discussion

Onion yield (t ha⁻¹)

Data about interactive effect of humic acid along with P on onion yield (t ha⁻¹) is given in (Table 2). Soil application of plant derived HA @ 300 mL 5 kg⁻¹ along with 80 kg ha⁻¹ P₂O₅ as DAP (100% P) recorded the highest onion yield of 13.47 t ha⁻¹. However it was statistically at par with the treatment receiving 75% (60 kg ha⁻¹) P application along with soil application of plant derived HA @ 150 mL 5 kg⁻¹. Similar findings have been reported by different researchers [19].

Table1. The basic soil characteristic of the experimental soil

Soil characteristics	Unit	Values
pH	-	7.21
EC (1:1)	(dS m ⁻¹)	0.2
NO ₃ -N	(mg kg ⁻¹)	2.8
Extractable K	(mg kg ⁻¹)	126
Extractable P	(mg kg ⁻¹)	2.15
CEC	Cmol kg ⁻¹	27.5
Textural Class		Clay loam

Table 2. Effect of Plant Extracted Humic Acid and P fertilizer application on onion yield (t ha⁻¹)

Phosphorus	Humic acid (HA)			
	HA (0)	HA 150 mL 5 kg ⁻¹	HA 300 mL 5 kg ⁻¹	Means
Yield (t ha ⁻¹)				
60 kg ha ⁻¹ P ₂ O ₅ (75 %)	9.6 c	13.47 a	10.4 bc	11.69 b
80 kg ha ⁻¹ P ₂ O ₅ (100 %)	12.93 ab	13.47 a	13.47 a	13.29 a
Means	11.265 b	13.47 a	11.935 a	

Means followed by similar letter(s) did not differ significantly at 0.05 level of significance

Phosphorus content in onion (%)

Phosphorus content in whole plant onion including bulb at maturity was analyzed (Table 3). The results showed that soil application of plant extracted humic acid @300 mL 5kg⁻¹ along with 80 kg ha⁻¹ P₂O₅ as DAP (100% P) showed significant concentration of P (0.22%) followed by P concentration

(0.21%) in the treatment receiving plant extracted humic acid @ 150 mL 5kg⁻¹ along with 60 kg ha⁻¹ P₂O₅. The increase in P concentration might be due to the prevention of P fixation in the soil and the formation of homophospho complexes, which are easily assimilable by the plants [20].

Table 3. Effect of Plant Extracted Humic Acid application on Phosphorus concentration (%) in onion

Phosphorus	Humic acid (HA)			
	HA (0)	HA 150 mL 5 kg ⁻¹	HA 300 mL 5 kg ⁻¹	Means
P Concentrations %				
60 kg ha ⁻¹ P ₂ O ₅ (75 %)	0.163 c	0.21 b	0.163 c	0.178 b
80 kg ha ⁻¹ P ₂ O ₅ (100 %)	0.213 b	0.21 b	0.223 a	0.215 a
Means	0.188 c	0.21 b	0.386 a	

Means followed by similar letter(s) did not differ significantly at 0.05 level of significance

Nitrogen content in onion (%)

Results reveal that onion N (%) content were increased with the interaction of plant derived HA and P fertilizer (Table 4). The results showed that soil application of plant extracted humic acid @ 150 mL 5kg⁻¹ along with 60 kg ha⁻¹ P₂O₅ as DAP (75% P) showed significant

concentration of N (4.1%) followed by N concentration (3.88%) in the treatment receiving plant extracted humic acid @ 300 mL 5kg⁻¹ along with 80 kg ha⁻¹ P₂O₅. The increased N concentration was supposed to be retarded nitrification process with humic

acid application enabling the slow availability of applied N [21].

Table 4. Effect of Plant Extracted Humic Acid application on N Concentration (%) in Onion

Phosphorus	Humic Acid (HA)			
	HA (0)	HA 150 mL 5 kg ⁻¹	HA 300 mL 5 kg ⁻¹	Means
N Concentration (%)				
60 kg ha ⁻¹ P ₂ O ₅ (75 %)	1.71 e	4.1 a	3.55 c	3.12 a
80 kg ha ⁻¹ P ₂ O ₅ (100 %)	2.7 d	3.69 bc	3.88 ab	3.42 a
Means	2.205 b	3.895 a	3.715 a	

Means followed by similar letter(s) did not differ significantly at 0.05 level of significance

Potassium content onion (%)

Potassium content in whole plant onion including bulb at maturity was analyzed (Table 5). Soil application of plant extracted humic acid did not affect significantly concentration of K in whole shoot onion. It may be due to

the complex bonding of nutrients with humic acid which suppress nutrients availability. These result were analogous to the findings made by other researchers [22]. However, the results show increasing trend of K content in onion with the application of plant extracted humic acid.

Table 5. Effect of Plant Extracted Humic Acid application on K concentration (%) in Onion

Phosphorus	Humic Acid (HA)			
	HA (0)	HA150 mL 5 kg ⁻¹	HA300 mL 5 kg ⁻¹	Means
K Concentration (%)				
60 kg ha ⁻¹ P ₂ O ₅ (75 %)	1.63	1.93	2.48 NS	2.01 NS
80 kg ha ⁻¹ P ₂ O ₅ (100 %)	1.66	2.15	2.33	2.04
Means	1.64	2.04	2.40 NS	

NS Non-Significant

Conclusion

Soil application of plant derived HA @ 300 mL 5 kg⁻¹ along with 80 kg ha⁻¹ P₂O₅ as DAP (100% P) recorded the highest onion yield of 13.47 t ha⁻¹. However it was statistically at par with the treatment receiving 75% (60 kg ha⁻¹) P application along with plant derived HA @ 150 mL 5 kg⁻¹. So application of inorganic fertilizers along with the humic acid may be recommended for increasing the yield of onion and also the P and N concentrations in onion crop.

Authors' contributions

Conceived and designed the experiments: IU Din & M Sarwar, Performed the experiments: D Intisar, Analyzed the data: QU Khan & MJ Khan, Contributed materials/ analysis/ tools:

D Fakhar, D Fasih & M Sarwar, Wrote the paper: D Intisar & QU Khan.

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