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Full Length Research Paper

Humic acids affect the bulb production of onion cultivars

Muhammad Sajid[1]*, Abdur Rab[1], Syed Tanveer Shah[1], Ibadullah Jan[1], Ihsanul Haq[1], Bibi Haleema[2], Muhammad Zamin[1], Riaz Alam[3] and Hayat Zada[4]

[1]Department of Horticulture, Agricultural University Peshawar, Pakistan.
[2]Federally Administered Tribal Areas (FATA), Agricultural Research Institute, Tarnab, Peshawar, Pakistan.
[3]Pakistan Agricultural Research Council (PARC), Mardan Station, Pakistan.
[4]Department of Plant Protection, Agricultural University Peshawar, Pakistan.

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An experiment was conducted at Pakistan Agricultural Research Council (PARC) Mardan Station, during winter 2010-2011 to investigate the "Humic acids affect the bulb production of onion cultivars". The experiment was laid out in randomized complete block design with split plot arrangement having three replications. Humic levels (0, 1, 2 and 3 kg ha^{-1}) were allotted to main plots, while cultivars (Swat-1, NARC and Parachinar Local) were subjected to sub plots. Full dose of phosphorous (90 kg ha^{-1}), potash (60 kg ha^{-1}) and half dose of nitrogen (60 kg ha^{-1}) were applied before transplanting while the remaining half dose of nitrogen (60 kg ha^{-1}) was applied after 25 days of interval. The growth and yield parameters of onion cultivars were significantly influenced by various levels of humic, as cultivar Parachinar Local showed more neck height (7.5 cm), plant height (80.9 cm), bulb weight (94.2 g), yield plot^{-1} (22.9 kg) and total yield ha^{-1} (36.1 tons) whereas 2 kg ha^{-1} of humic significantly increased neck height (7.6 cm), plant height (75.3 cm), bulb weight (96.4 g), yield plot^{-1} (22.4 kg) and total yield ha^{-1} (35.86 tons), a non significant response was recorded for survival percentage. In interaction of onion cultivars × humic level indicated that Parachinar Local, fertilized with 2 kg ha^{-1} humic showed best performance for most of the growth and yield parameters. It is concluded that onion cultivar Parachinar Local and application of humic at 2 kg ha^{-1} resulted in higher growth and yield for onion.

Key words: Humic acid, growth parameters, yield, onion cultivars.

INTRODUCTION

Onion (*Allium cepa* L.) belongs to the family Amaryllidaceae which is one of the most important mono-cotyledonous crops. It is a cross pollinated and cool season vegetable crop. It is widely used and most important vegetable crop which is grown in temperate and tropical regions of the world. The pungency of the onion bulbs is due to the presence of a volatile oil that is allylpropyl disulfide (Baloch, 1994). In Pakistan, the total production of onion is 1704100 tons and is cultivated on an area 129600 ha. Average yield per hectare in Khyber Pakhtunkhwa is 11.3 tons per hectare and total area under onion cultivation is 12.100 thousand hectare with a production of 136400 tons (MINFA, 2009). Shoot length and biomass of onion and garlic expressed either in fresh or dry weight, increased significantly under GA_3 (Ouzounidou et al., 2011). By the application of Humic substance to plants, the growing plants are supplied with food, its application also results in productive and fertile soil, which increase the water holding capacity of soil. It plays a pivot role in making the plants more resistant against drought stress, and also stimulates germination. The application of Humic reduces the requirement of other fertilizers. It also increases crop yield, soil aeration, and drainage can also be improved by Humic, the

*Corresponding author. E-mail: sajidhort@hotmail.com.

establishment of desirable environment for the development of microorganisms. Increase in the protein and mineral contents of most crops is possible by the application of Humic substances. The application of Humic substances increased the yield in soybeans, potatoes, and algae cultures. It also plays an important role in increasing the fruit yield, also the quality of squash plants are increased by Humic substances application. 100% increase in the yield of potatoes and cabbage can be achieved by combined application of NPK fertilizers and Humics (Syabryai et al., 1965). Humic is technically not a fertilizer, although in some walks, people do consider it that, Humic is an effective agent use as a complement to synthetic or organic fertilizers. In many instances, use of Humic regularly, will reduce the need for fertilization due to the soil's and plant's ability to make better use of it. In some occurrences, fertilization can be eliminated entirely if sufficient organic material is present and the soil can become self sustaining through microbial processes and humus production. Whenever possible, the use of Humic with fertilizer, Humics' ability to absorb fertilizer components and increases their release to plants is well documented. The judicious use of Humic and fertilizer, will improve the performance of marginally fertile soils, of soils with low native organic matter, and of crops grown in arid regions (Chen and Aviad, 1990).

Humic acid is a natural product, which is present in Pakistan's lignitic coal in reasonable concentration and is used in agriculture and industry but on limited scale (Hai and Mir, 1998). Humic substances are formed through the process of humification of organic materials as by-product of microbial metabolism and are found in soil, coal, sediments water, peat and organic matter (Stevenson, 1994). HA is a complex molecule and is considered an alkali soluble, polymeric organic acid of aromatic structure substituted by carboxyl, phenolic, hydroxyl and alkyl groups linked together by ester linkages (Gaines and Yilmaz, 1983). Recent critical review on the molecular structure in soil, humic substances (Sutton and Sposito, 2005) presented a new study area, a view on the basis of recent published data obtained from NMR spectroscopy, X-rays absorption near edge structure spectroscopy and pyrolysis. According to their view, humic substances are clusters of diverse, relatively small organic molecules linked by H^+ bonds and hydrophobic interactions. The properties of Base Exchange capacity and complexing ability of HA are important in soil stability, transport of metal ions in the soil to plants tissues, stabilization of SOM against microbial attack, and because of its ability to form complexes; it is believed to convert nutrients into form suitable for assimilation by plants (Vaughan and Mec Donald, 1976). HA contains organic C (51-57%), N (4-6%) and P (0.02%). It is believed that these HA elements improve crop yield due to its capability of supplying N and P to the plants. But the total amount of HA added as fertilizer is generally one or two kg ha^{-1}, which could supply 0.04-0.08 kg N and 0.001 kg P ha^{-1} to soil (Brannon and Sommers, 1985).

MATERIALS AND METHODS

An experiment to study the effect of Humic acids on bulb production of onion cultivars was conducted during 2010-11 at Pakistan Agricultural Research Council (PARC) Mardan Station. The land was thoroughly prepared. A plot size of $6m^2$ was used for the experiment. Nursery of the onion cultivars was taken from vegetable section, Agricultural Research Station (North) Mingora Swat. The onion seedling was transplanted in well prepared field during the month of December. The land was divided in to main and sub plots where Humic allotted to main plots and onion cultivars were subjected to subplot, the row to row distance was 20 cm while plant to plant distance was 10 cm. The experiment was laid out in Randomized Complete Block design (RCBD) with split plot arrangement. There were twelve treatment combinations and each was replicated three times. All the cultural practices such as weeding, hoeing, sprays against insect pests and diseases except fertilizer application were done uniformly. The experiment consisted of two factors as Humic levels (0, 1, 2 and 3 kg ha^{-1}) and Onion cultivars (Swat-1, NARC and Parachinar Local). The data was recorded on the following growth and yield parameters.

Survival percentage

The number of plants which survived after transplanting was counted in each treatment and the percentage was calculated by the following formula.

$$\text{Survival percentage} = \frac{\text{Number of plants survived}}{\text{Total number of transplanted plants}} \times 100$$

Neck height (cm)

The neck height of 5 randomly selected plants was measured with the help of a meter rod from the bulb top surface to the point where leaves start to separate and the average was calculated.

Plant height (cm)

The data pertaining to plant height was recorded in centimeters at the end of the growing seasons, that is, at harvest by measuring the plant from soil surface to the tip of the main stem by taking 5 randomly selected plants from each plot and after that means were estimated.

Bulb weight (g)

Single bulb weight was measured with the help of electronic balance by weighing 5 randomly selected plants from each plot for all treatments in each replication and the average were calculated.

Yield (kg $plot^{-1}$)

All the harvested onions were weighed after harvesting. The yield data was recorded in kilograms for each plot in each replication and the average yield (kg $plot^{-1}$) was calculated.

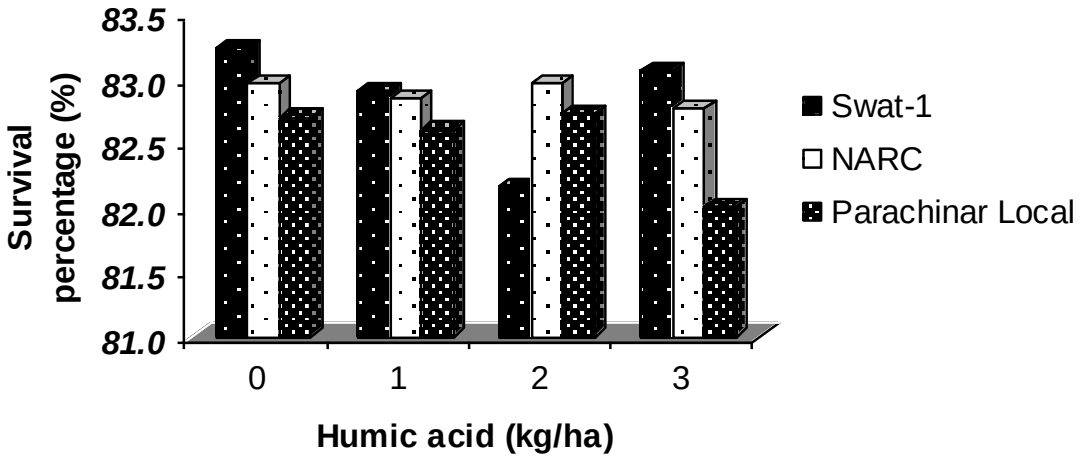

Figure 1. Survival percentage of onion cultivars as affected by humic acid.

Total yield (tons ha^{-1})

All the harvested onion bulbs were weighed after harvesting. The total yield data was recorded in tons and yield per hectare was calculated.

Statistical procedure

The data recorded on different parameters were subjected to analysis of variance (ANOVA) technique to find out the difference between the different treatments and their interactions. In cases where differences were found significant, the means were compared for differences using Least Significant Difference (LSD) test. Statistical computer software, MSTATC (Michigan State University, USA), was applied for computing both the ANOVA and LSD (Steel and Torrie, 1980).

RESULTS AND DISCUSSIONS

Survival percentage

The onion cultivars, Humic acid and their interaction had non-significant effect on survival percentage (Table 1 and Figure 1).

Neck height (cm)

From the data analyzed statistically, it is observed that the cultivars, Humic acid and interaction all significantly affects the neck height (Table 1). Mean value of neck height for different cultivars indicated that cultivar Parachinar Local showed the highest neck height (7.5 cm). A non significant was seen for cultivars Swat-1 and NARC in which the lowest Neck height was recorded for cultivar NARC (6.0 cm). Mean value for Humic acid levels also showed significant difference among them. Highest Neck height (7.6 cm) was recorded for 2 kg ha^{-1} Humic acid but a non-significant response was seen in plants fertilized with 3 kg ha^{-1} while a significant difference with plants fertilized with 1 kg ha^{-1} and control treatment in which less neck height was recorded in plants untreated (5.3 cm). The mean value for interaction also has a significant effect on the neck height in which the highest neck height (9.5 cm) was recorded for Parachinar Local and 2 kg ha^{-1} Humic acid followed by 3 kg ha^{-1} Humic acid and Parachinar Local (8.9 cm) whereas, least neck height (4.9 cm) was recorded for cultivar Swat-1 untreated with Humic acid (Figure 2). The increase in neck height of onion is due to the varietal differences among the cultivars under trail and differences in their genetic make up. The results of Chen and Aviad (1990) are consistent with this study; who suggested that soil-applied Humic acid would be necessary to result in an improvement in crop production. Similarly our results for certain extent, agreed with the results of Pandey et al. (1992), who reported that greatest neck thickness with 1st June sowing instead of 30th June, 15th July or 30th July.

Plant height (cm)

The onion cultivars and Humic acid levels significantly influenced the plant height whereas, their interaction showed a non significant difference (Table 1). Mean table for plant height of different cultivars showed the greater plant height (80.9 cm) was observed for cultivar Parachinar Local whereas a non significant response was recorded for cultivars Swat-1 and NARC in which the lowest plant highest (63.7 cm), recorded for NARC. Mean values for plant height for different Humic acid levels also showed significant differences. Highest plant height (75.3 cm) was recorded for Humic acid 2 kg ha^{-1} which was statistically the same as 3 kg ha^{-1} Humic acid, while a significant difference was observed as compared to control treatment which had the least plant height (63.7

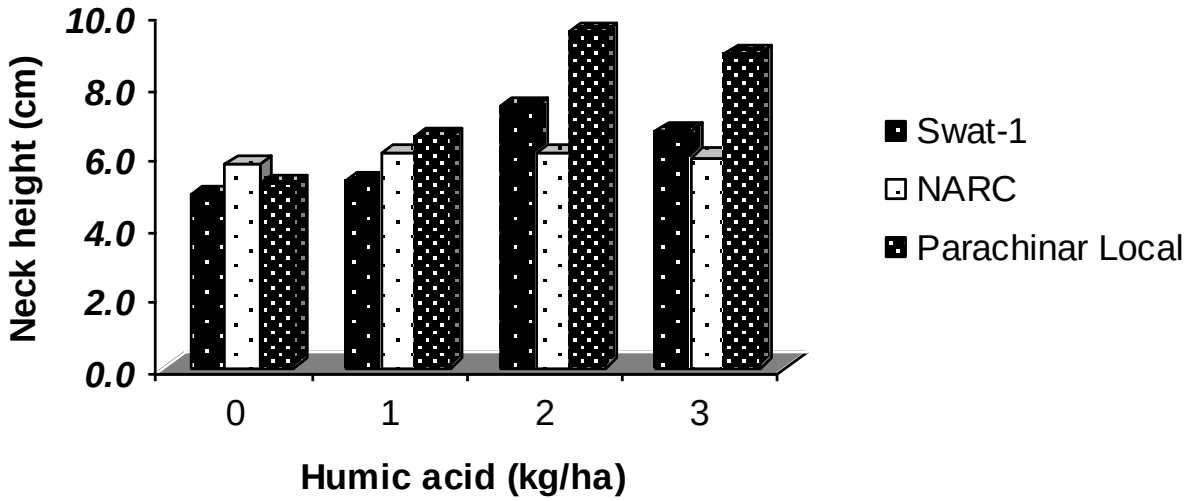

Figure 2. Neck height (cm) of onion cultivars as affected by humic acid.

Table 1. Survival percentage (%), Neck height (cm) and Plant height (cm) of Onion cultivars as affected by Humic levels.

Parameter	Survival percentage (%)	Neck height (cm)	Plant height (cm)
Cultivar			
Swat-1	82.8	6.1 b	65.4 b
NARC	82.9	6.0 b	63.7 b
Parachinar local	82.5	7.5 a	80.9 a
LSD Value	NS	0.443	3.693
Humic level (kg ha^{-1})			
Control	83.0	5.3 b	63.7 c
1 kg ha^{-1}	82.8	6.0 b	68.9 b
2 kg ha^{-1}	82.6	7.6 a	75.3 a
3 kg ha^{-1}	82.6	7.2 a	72.0 ab
LSD value	NS	1.103	3.330
Interaction (H × C)			
LSD value	NS	S	S

cm). As far as interaction was concerned the cultivars and Humic acid levels had a non significant affect (Figure 3). The variation in plant height among different cultivars may be due to the differences in genetic makeup of the various cultivars under trail and adaptation ability of these cultivars to particular environment. Similarly, the findings of Majeed (1986) are of great importance in this connection and evaluated 6 onion cultivars and reported that Swat-local and Faisalabad onion cultivars were the tallest cultivars with a plant height of 55.00 and 53.40 cm, respectively. The increment in plant height of onion by Humic acid application may be due to the role of Humic acid on improving the soil fertility and increasing the availability of nutrient elements and consequently increased plant growth. These results are in harmony with those reported by Erik et al. (2000) and El-Desuki (2004) on onion. They reported that Humic acid application led to a significant increase in soil organic matter which improving plant growth and crop production.

Bulb weight (g)

The different onion cultivars, Humic acid levels and their interaction significantly influenced the bulb weight of onion bulbs (Table-2). Mean value of bulb weight for different onion cultivars indicated that more bulb weight (94.2 g) was noted in cultivar Parachinar Local bulbs which were significantly indifferent with cultivar Swat-1 (92.3 g) while different from cultivar NARC where the least bulb weight (82.7 g) recorded**.** The application of Humic acid showed a significant difference for bulb

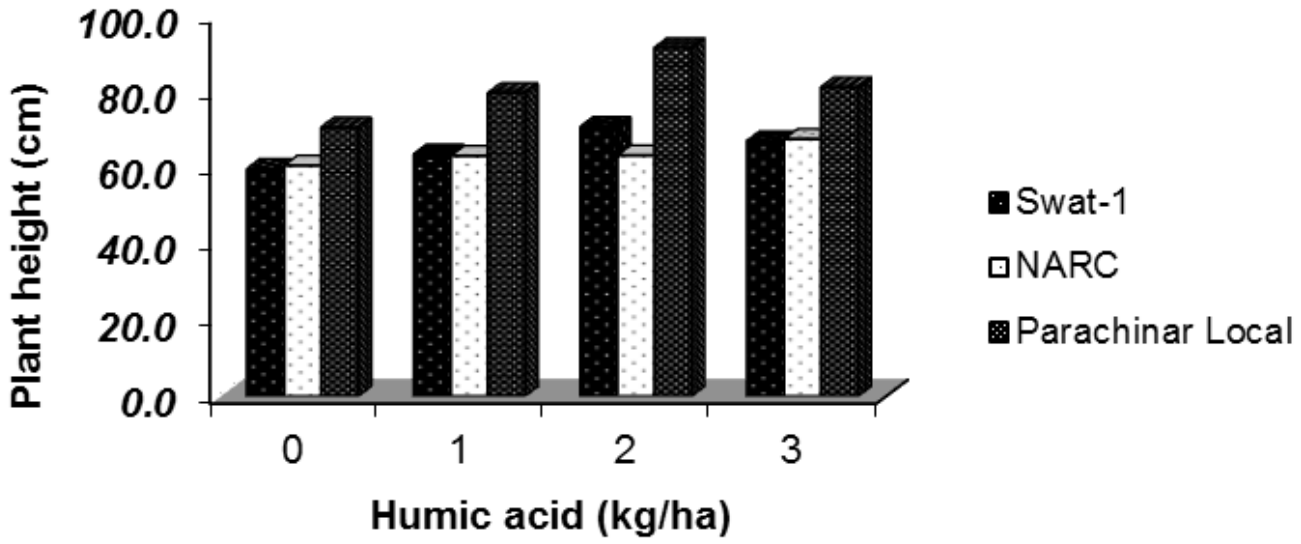

Figure 3. Plant height (cm) of onion cultivars as affected by humic acid.

Table 2. Bulb weight (g), Yield plot^{-1} (kg) and Total yield ha^{-1} (tones) of Onion cultivars as affected by Humic levels.

Parameter	Bulb weight (g)	Yield plot^{-1} (kg)	Total yield (t)
Cultivar			
Swat-1	92.3 a	20.9 b	32.9 b
NARC	82.7 b	19.5 c	30.5 c
Parachinar Local	94.2 a	22.9 a	36.1 a
LSD Value	4.440	0.837	1.397
Humic level (kg ha^{-1})			
Control	84.4 b	19.9 c	31.1 c
1 kg ha^{-1}	92.0 a	20.9 b	32.9 b
2 kg ha^{-1}	96.4 a	22.4 a	35.3 a
3 kg ha^{-1}	86.2 b	21.2 b	33.3 b
LSD value	5.214	1.032	1.744
Interaction (H × C)			
LSD value	S	S	S

weight of onion cultivars. More bulb weight (96.4 g) was recorded in plants that were fertilized with 2 kg ha^{-1} Humic acid which was statistically similar with plants, received 1 kg ha^{-1} Humic acid but different from the other Humic acid levels. There were non significant differences in bulb weights of plants, received 0 and 3 kg ha^{-1} Humic acid, however the lowest bulb weight (84.4 g) was noted in plants, untreated with Humic acid. The interaction of Humic acid and onion cultivars had significantly influenced the bulb weight. More bulb weight (103.5 g) was recorded in cultivar Parachinar Local, fertilized with 2 kg ha^{-1} Humic acid, which was significantly different from the rest of treatments followed by cultivar Swat-1, fertilized with 3 kg ha^{-1} Humic acid. All other treatments were some what similar where the lowest bulb weight (77.9 g) was recorded in cultivar NARC, untreated with Humic acid (Figure 4). This variation among the cultivars under trail may be due to genetically differences of these cultivars. The varietal difference may cause an increase in bulb size and weight (Khan et al., 2001). Similarly, Humic acid significantly affects the bulb yield of the crop by increasing the nutrients availability to the plants. The findings of present research is in line with the findings of Mahmoud and Hafez (2010), who reported that the vegetative growth parameters, potato yield and tuber size, weight and quality as well as nutritive value of

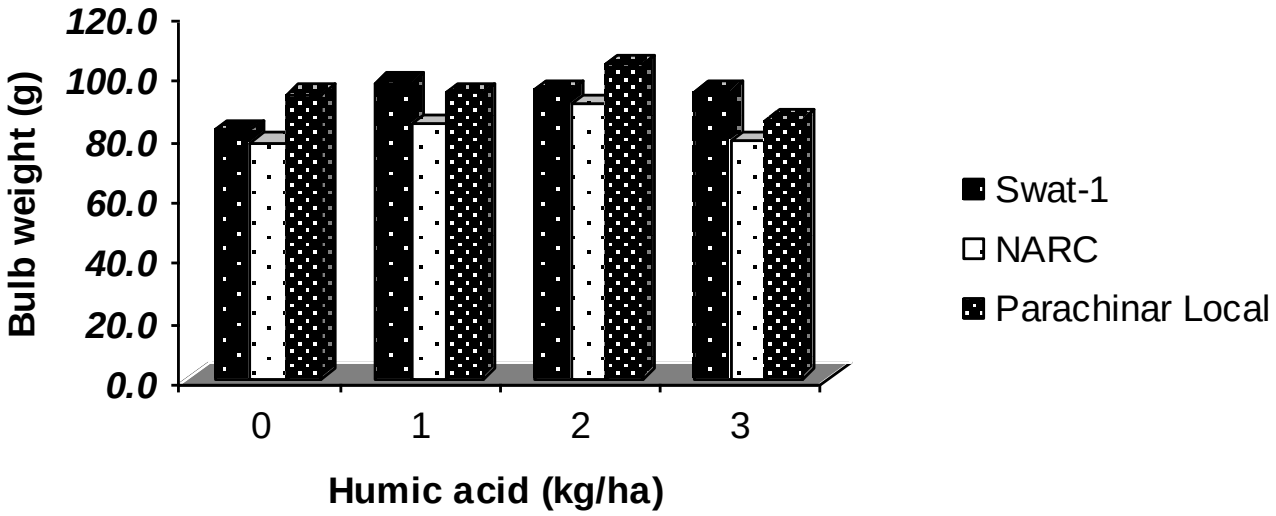

Figure 4. Bulb weight (g) of onion cultivars as affected by humic acid.

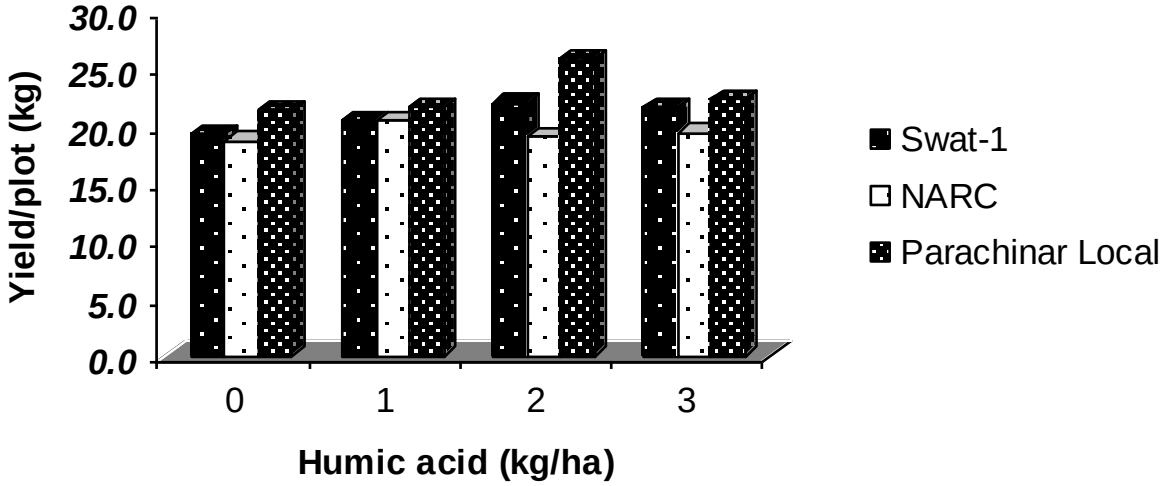

Figure 5. Yield/plot (kg) of onion cultivars as affected by humic acid.

potato tuber were significantly increased with increasing the level of Humic acid application from 0 up to 2 kg Humic acid/ha.

Yield plot^{-1} (kg)

The data regarding yield plot^{-1} of onion cultivars stated that different cultivars, Humic acid and their interaction had a significant affect on onion cultivars (Table 5). Mean value of yield plot^{-1} for different onion cultivars showed that more yield plot^{-1} (22.9 kg) was recorded in cultivar Parachinar Local, followed by cultivar Swat^{-}1 (20.9 kg), whereas the least yield plot^{-1} (19.5 kg) was recorded in cultivar NARC. The application of Humic acid significantly increased the yield plot^{-1} of onion cultivars. Mean values of the table showed that highest yield plot^{-1} (22.4 kg) was noted in plants, fertilized with 2 kg ha^{-1} of Humic acid. A non significant difference was noted in the plots that received Humic acid at 1 (20.9 kg) and 3 kg ha^{-1} (21.2 kg) respectively, while control treatment gave the least yield plot^{-1} (19.9 kg). The yield plot^{-1} was significantly influenced by the interaction of Humic acid and onion cultivars. The highest yield plot^{-1} (26.0 kg) was depicted in cultivar Parachinar Local, fertilized with 2 kg Humic acid ha^{-1}. The unfertilized plants in control treatment of cultivar NARC showed the lowest yield plot^{-1} (18.8 kg) (Figure 5). This may be due to the fact that yields vary considerably depending upon different cultivars. Different cultivars had various genetic potential in relation to their

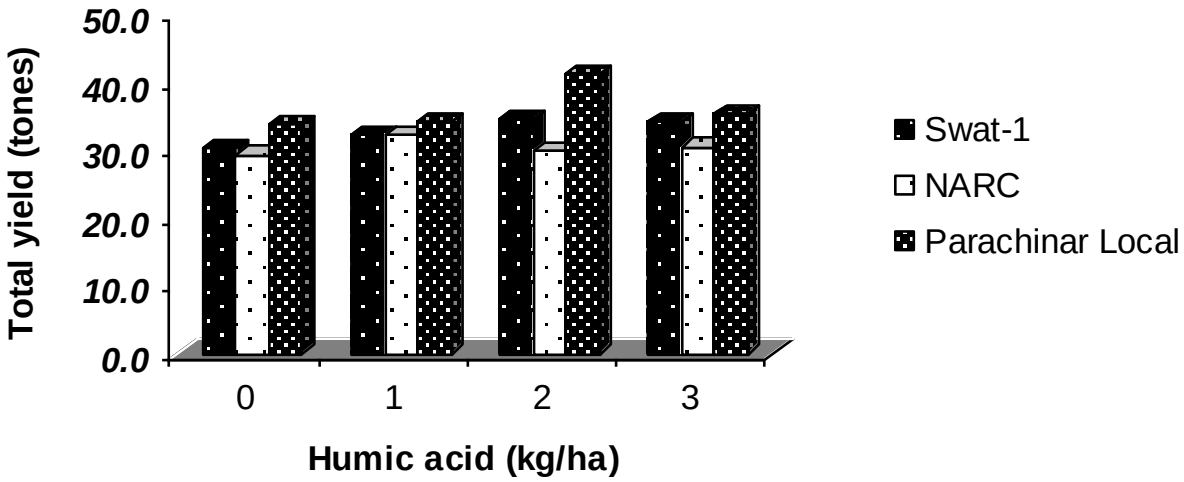

Figure 6. Total yield (tones/ha) of onion cultivars as affected by humic acid.

growth and yield component (Young et al., 2004). The mentioned results are also in conformity with the findings of Sych (1986), who compared 120 different onion cultivars in two growing seasons and reported that cultivars, 'Margelanski Mastnyi' and 'inspansk 313' gave the highest yield (3.29 and 2.82 kg/m^2) respectively, depending on its genetic makeup. Humic acid substances are usually applied to the soil, and favorably affect the soil structure and soil microbial population and hence make available the essential nutrients to the plant which in turn increased the yield of the crop. Our results are in line with the study of Brannon and Sommer (1985) and Malcom and Vaughan (1979), who reported that Humic acid improve the Physico-chemical and biological condition of the soil.

Total yield (tons ha^{-1})

The different cultivars of onion, Humic acid levels and interaction, all showed significant response (Table 2). Mean value of Total yield for different cultivars indicated that greater yield (36.1 tons) was recorded for Parachinar Local which was statistically different from Swat-1 and NARC in which NARC gave the least yield (30.5 tons). Mean values for Humic acid levels indicated that total yield showed significant response to Humic acid levels in which highest total yield (35.3 tons) was observed for Humic acid 2 kg ha^{-1} followed by 3 kg ha^{-1} Humic acid level which had a non significant difference with 1 kg ha^{-1} Humic acid level, whereas control treatment showed the lowest total yield (31.1 tons). Mean values for interaction also showed significant response to total yield. Greater total yield (41.3 tons) was observed for cultivar Parachinar Local and Humic acid 2 kg ha^{-1} while minimum total yield (29.3 tons) was recorded in control treatment and cultivar NARC (Figure 6). This might be due to the fact that different onion cultivars significantly vary in the characteristics with respect to the yield because of their genetic makeup. The results of Blandon (1969), are of primary importance in this regard. Who compared 10 onion cultivars and reported that cv. 'Granex' gave the highest yield (48 ton/ha). These results also agree with the findings of Betancourt and Rivas (1973), Singh and Pandy (1974) and Vigario (1975). Similarly, the influence of Humic acid significantly affect the total yield, it might be due to the properties of Humic acid in increasing the fertility level of the soil, and also providing and make available the essential nutrients for the better growth of the plant and hence the increase in the yield of the crop. The results best suited with findings of kirn et al. (2010) who indicated in their results that HA significantly increased yield when applied with full recommended fertilizer in okra.

Conclusions

Based on the data analyzed, it is concluded that Onion cultivar "Parachinar Local" results in higher bulb yield (tons ha-^{1}) followed by cultivar "Swat-1" and the minimum yield was obtained from cultivar "NARC". As far as the effect of Humic acid is concerned the results concluded that 2 kg ha^{-1} gives the higher bulb yield followed by 3 kg ha^{-1} Humic acid level and the minimum yield was obtained in control treatment ,that is, Humic acid at 0 kg ha^{-1}.

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