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Research article

ENHANCING THE VASE LIFE OF TULIP (*TULIPA GESNERIANA* L.) USING VARIOUS PULSING SOLUTIONS OF HUMIC ACID AND NPK

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ABSTRACT: The aim of this experiment was to investigate the effect of various humic acid concentrations and NPK levels for vase life response of Tulip (*Tulipa gesneriana* L.) cv. Triumph. The data was statistically analysed by using complete randomized design (CRD) in three replications and observations were recorded at two intervals (Ist at: 5 days, 2nd at: 10 days). Three concentrations of humic acid (25, 50, and 75 ml/l) along with NPK dose was applied which were compared with control. The statistical results revealed that all measured traits increased with increase in humic acid concentration and treatment combination of humic acid (HA) and NPK produced a significant difference in post harvest attributes than a single application. The highest values for quality parameters like scape length (30.95 cm and 34.12 cm), tepal diameter (10.34 mm and 11.89 mm), water uptake (66.95cm^3 and 62.87cm^3), fresh weight (33.21g and 38.32g) and minimum stem curvature percentage (17.23% and 19%) were observed in T_5 (*75 ml/l humic acid + 10 g/l NPK*) as compared to control (T_0=distilled water) at two intervals. Concerning the influence of humic acid and NPK for vase life, T_5 also had a superior effect on days for vase life (18.70 days) as compared to other treatments.
Keywords: Flower vase life, Flower quality, Vase solutions, Humic acid, NPK, Tulip.

INTRODUCTION

The tulip (*Tulipa gesneriana* L.) is an important ornamental bulbous plant which belongs to the family, Liliaceae. It is one of the most popular spring of all time having curvaceous and colorful flowers which widely cultivated as a perennial throughout the world [34]. As ranked one of the third most popular cut flowers world-wide next to Rose and Chrysanthemum, the largest area under any true bulb crop in the world is that of *Tulipa*, followed by *Narcissus*, *Iris*, *Hyacinthus* and *Lilium* [32]. Floriculture is an important component of horticulture in which cut flowers are precious products of this field. Tulip not only plays an important role in the florist trade, but also performs well in the garden as a bedding plant. Their consumption has increased in most of spiritual and traditional events like Christmas, Valentine, Mother's Day and Happy New Year festivities [37]. Prolonged vase life is one of the most important factors for quality of cut flowers. Maintaining good quality of cut flowers and extending the vase life, are considered important and practical for having acceptable products for the markets. But the Tulip has short vase life and bent neck and flower senescence are the major problems that reduce their post harvest significance. Being an ethylene sensitive cut flower, petal senescence in tulips is responsible for a reduction in the quality and vase life of the flowers [10]. Such changes have a major negative impact upon its marketing value. The senescence after cutting generally has been attributed mainly due to ethylene production. This presence of ethylene leads to flower degradation in terms of flower senescence, chlorosis, loss of bright color and shortening of petals life [16]. Postharvest senescence is a major limitation to the marketing of many species of cut flowers and considerable effort has been devoted to developing postharvest treatments to maintain the aesthetic value and also extend the marketing period. The addition of these chemical holding solutions is recommended to prolong the vase life of cut flowers. All holding solutions usually contain two ingredients namely, sugar and germicides. The sugars provide a respiratory substrate, while the germicides control bacterial growth and prevent plugging of the conducting tissues [25] and [38]. Along with preservative solutions, humic acid and NPK supplements improved petal color, increased bud opening, strengthened pedicels, and extended overall inflorescence longevity by up to 8 days. Miscellaneous evidence has demonstrated that humic acid plays an important regulatory role in multiple plant

physiological processes as a plant growth regulator and delays the process of senescence in flowers [26]. For examples, Vase life for up to 10 days and petal protein contents (32.76%) in Chrysanthemum *(Dendranthema grandiflorum)* flower was improved with respect to control when humic acid was applied with another compound [33]. In another experiment, [19] claimed that Humic acid has an active ingredient to extend the postharvest process. Humic acid with the concentration of 50ml/l involved in extension of vase life (17 days), reduced stem curvature phenomenon (49%) and increase fresh flower weight (4.96%) in Gerbera (*Gerbera jamesonii L.*). Mineral fertilizers (NPK) were also played an important role in the improvement of vase life characteristics in ornamental Amaryllis flower [24]. NPK fertilizers have a remarkable contribution in the extension of the postharvest life of cut flowers. Nitrogen and phosphorous are essential elements for post harvest growth [6]. Mentioned in various studies in which numerous researchers summarized that NPK are the nutritional macro elements which have an imperative role in vigorous growth, yield and quality of the flower. [20]; [13]; [29]. By keeping in view, the significance and importance of Tulip, this paper aimed to increase the post harvest life and other quality related characters of Tulip by application of different concentrations of humic acid and NPK.

MATERIALS AND METHODS

This experiment was carried out at Post-Harvest Lab of Floriculture, Institute of Horticultural Sciences, University of Agriculture, Faisalabad, Pakistan during 2011-2012 to prolong the vase-life of Tulip (*Tulipa gesneriana L.)* cv. Triumph through use of humic and NPK solution as a floral preservative. A complete randomized design (CRD) was applied with different levels of Humic acid (25, 50, and 75 ml^{-1}) and two levels of NPK (50 and 10g/l) in 3 replications (Table 1). Distilled water was used for the control. Data regarding scape length, stem curvature %, tepal diameter, water uptake, fresh weight and flower vase life were recorded at five and ten day interval. Approximately 175 tulip bulbs were grown in a greenhouse condition in late November and harvested from February to March at when half flower bud was to be opened. Observations for vase life attributes were recorded days taken for tepal wilting, drooping of flower heads and the total quantity of solution absorbed by the flower. The flowers were harvested early in the morning and were immediately shifted to Post harvest lab and then placed in water for pre-cooling for 2 hours to remove the effect of high field heat. The stalks were cut again prior to placing them in holding solution to study the keeping quality. About 25 cm long stalks length prepared for placing into holding solution. The flowers were then placed in different combinations of Humic acid and NPK vase solution. The tubes were kept at room temperature (26±2°C), RH of 60-65% and 24 hrs light with fluorescent lamps to complete vase life.

Table 1: Treatment Plan.

Treatments	Description
T_0	Control (Distilled water)
T_1	25 ml/l Humic acid
T_2	50 g/l NPK
T_3	25 ml/l Humic acid + 10 g/l NPK
T_4	50 ml/l Humic acid + 10 g/l NPK
T_5	75 ml/l Humic acid + 10 g/l NPK

Experimental design and Statistical Analysis

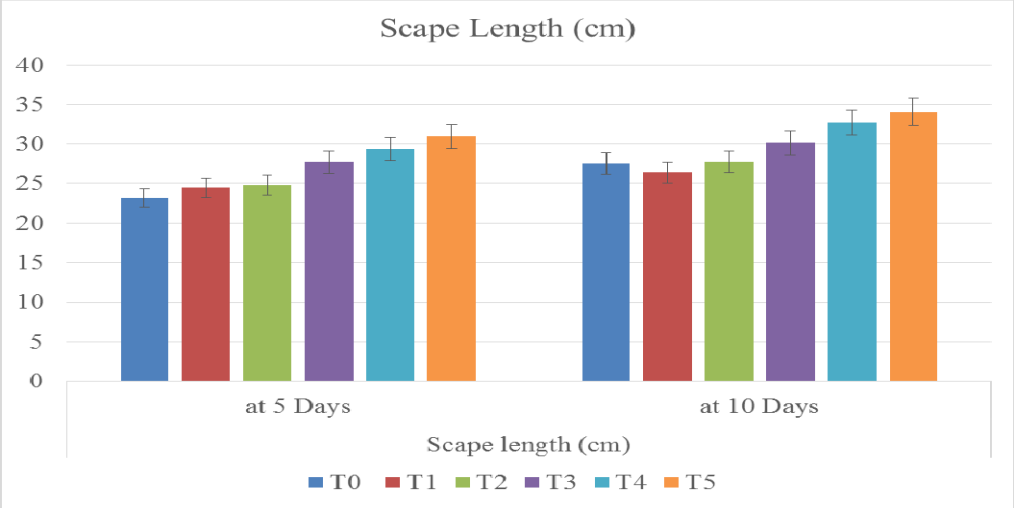
The experiment was arranged with a Complete Randomized Design (CRD) with 6 treatments. The data regarding all postharvest parameters were investigated statistically by performing analysis of variance techniques [35]. In case of significant treatment effects, comparison of means were separated by using LSD test (P= 0.05).

RESULTS AND DISCUSSION

Role of humic acid and NPK in Scape length (cm)

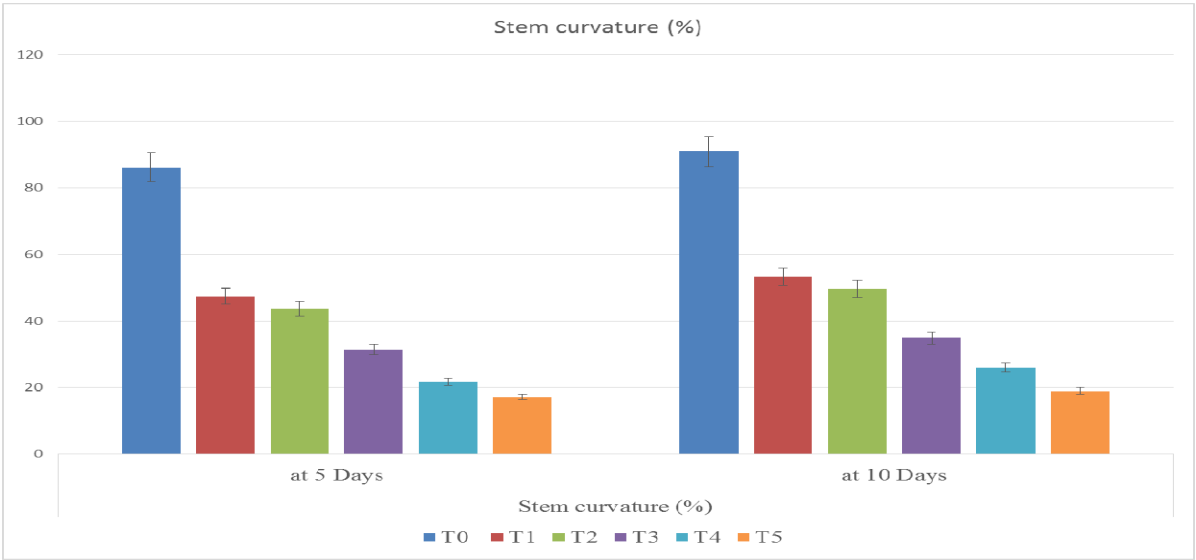
Scape length is an important parameter which determines the market value of cut tulip. Statistical analysis of data in Table 2 regarding scape length showed significant difference among different treatment means. Scape length was observed at 2 intervals (1^{st} at: 5 days, 2^{nd} at: 10 days). These results revealed that stalk length was increased with the increase in humic acid concentration that advocated the significance of humic acid. Highest scape length (30.95 and 34.12 cm) was noticed in T_5 (75 ml/l Humic acid + 10 g/l NPK) while the least scape length (23.12 cm and 27.54 cm) was measured in T_0 control where flowers were placed in distilled water. This may be due to improvement of plant growth in terms of scape elongation by hormone like activity of Humic acid (HA) which improved tissue water status which are the prerequisite for normal metabolism and growth. These results are in harmony with those of [36] who reported the significant effect of different levels of HA on stem length improvement.

This is well documented by many other researchers ; they reported that plant height and stalk length increased in different bedding plants when humic acid applied with 50, 75, 100 and 150 ml/l concentration [4] and [5]. The increase in stalk length might be due to the availability of nutrition to the plant. [28] observed that combined NPK applications may elevate the nitrogen, potassium and phosphorus contents and the increase in stalk length might be due to elevated levels of macronutrients which have a positive effect on floral characteristics.



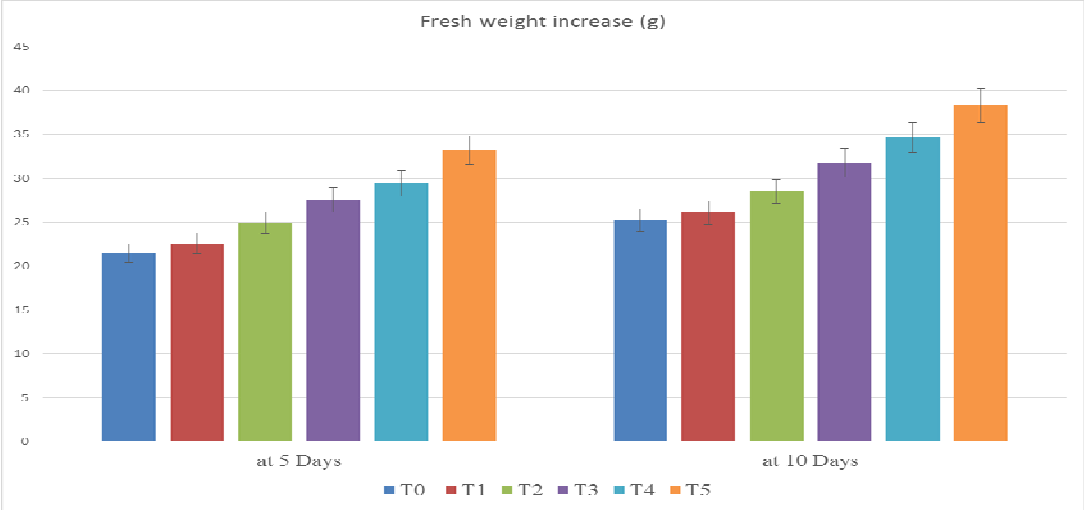
Role of humic acid and NPK in Stem curvature (%)

Data concerning the stem curvature (%) as affected by humic acid & NPK concentration are presented in Table 2 and the results revealed significant differences among treatments. The stem curvature % was reduced by increasing the humic acid dose when observation was recorded at 2 intervals (I^{st} at: 5 days, 2^{nd} at: 10 days). A minimum reduction in stem curvature phenomenon examined in T_5 which was 17.23% and 19% as compared to all other treatment. Control treatment (T_0= distilled water) did not participate effectively in stem curvature reduction and maximum damage percentage (86.15% and 91%) was examined at two intervals. Meanwhile, combine dose of humic and NPK played remarkable role in delaying the senescence process than a single application. Scape curvature percentages in cut flowers are mainly associated with low water potential. Presence of bacteria in the vase water of cut *Tulipa gesneriana* flowers resulted in an increase in scape curvature depending on the concentration of bacteria in the water, which block the xylem conduits, resulting in low turgor but the chance of bent scapes reduced when the vase solution contain HA ingredients which act as an antibacterial compounds and prolong the vase life attributes [27]. Our results are accorded with finding of [15] who reported that salicylic acid significantly decreased bacterial population in the preservative solution and reduced stem curvature in Gerbera cut flower. Application of humic acid increases calcium accumulation in the stem of Gerbera and then vase life increased and stem bent reduced significantly [37].



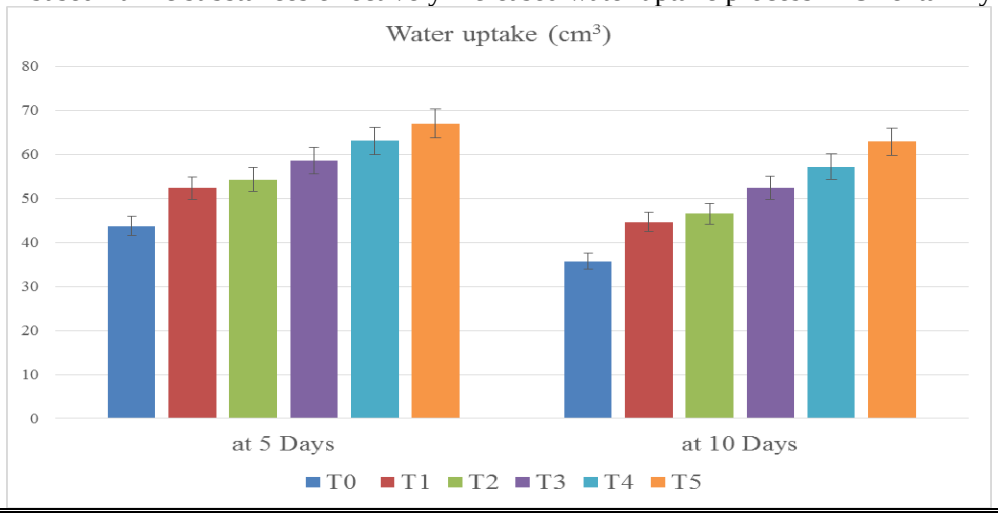
Role of humic acid and NPK in fresh weight increase (g)

Data regarding fresh weight of flowers as influenced by different humic acid and NPK concentration are presented in Table 2 and the results revealed significant difference among treatments. The combination of HA and NPK levels obviously increased the fresh flower weight, when compared with a single application. Maximum fresh weight of flower was observed in T_5 (75 ml/l Humic acid + 10 g/l NPK) which was 33.21g and 38.32g recorded at 2 intervals (I^{st} at: 5 days, 2^{nd} at: 10 days) respectively. Least fresh flower weight (21.45g and 25.25g) was obtained based on 5 and 10 days duration in plants supplied with distilled water (control). Increment in fresh weight is directly proportional to HA and NPK concentrations, this is the significance of humic acid and macronutrient which have apparently a vital role in the blooming rate and fresh weight; our results are consistent with the findings of [3]. A similar response was observed for fresh weight of a flower with the best results by higher HA concentrations, which confirmed the positive effect on reproductive growth of carnation cut flowers [17]. Highest relative fresh mass content in cut Alstroemeria was obtained with higher concentrations of humic acid (100 ppm) which reported by [8] Maximum fresh flower weight (284.69 g) obtained @ 2000 mgl^{-1} humic acid treatment in marigold (*Calendula officinalis L.*) flower [23]. Humic acid has a "direct action" on plant metabolic mechanism and findings claimed that HA has beneficial & hormonal effects on the food uptake by plants and is particularly important to the transportation and availability of micronutrients and consequently increase mass production in Gerbera cut flower [3] and [27].



Role of humic acid and NPK in water uptake (cm^3)

Data obtained for water uptake (cm^3) was subjected to statistical analysis and the results were found to be significant. The highest water uptake value was recorded in T_5 holding solution in the range of 66.95- 62.87 cm^3 followed by T_4 (63.10-57.25 cm^3), T_3 (58.67-52.47 cm^3), T_2 (54.31-46.54 cm^3) and T_I (52.34- 44.70 cm^3) while minimum values were observed in control treatment which were 43.74-35.80 cm^3 at two intervals (I^{st} at: 5 days, 2^{nd} at: 10 days) respectively. These results are harmonious with the findings of [19] who found that water uptake by plant significantly increased by the addition of inputs in *Polianthus tuberosa* cv. Double. Same results was painted by [9] who demonstrated that the application Calcium based humic substances effectively increased water uptake process in Oriental lily flower.



Role of humic acid and NPK in tepal diameter (mm)

Data concerning tepal diameter (mm) as affected by humic acid & NPK concentration are presented in Table 2 and the results revealed significant differences among treatments. A progressive role of HA was determined in the enhancement of tepal diameter, which increased by increasing the HA concentration. The maximum tepal diameter was noticed in T_5 holding solution in the range of 10.34-11.89 mm followed by T_4 (9.39-10.51 mm), T_3 (7.65-8.03 mm), T_2 (7.00-7.33 mm) and T_I (6.06-6.64 mm) while the minimum tepal diameter was observed in the control treatment (Distilled water) which were 5.65-6.28 mm at two intervals (I^{st} at: 5 days, 2^{nd} at: 10 days) respectively. The increase in flower bud diameter and flower opening is due to the addition of vase solution which consists of biocides reagent accelerated the physiological process and improved tissue water status in normal metabolism and plant growth [30]. In marigold (*Tagetes erecta*, 'Double Eagle') growth, [1] suggested that the proper combination of fertilizers plays a vital role in the production of vigorous plants having maximum number of shoots and leaves, which have a positive impact on quality flower production and prolonged flowering period. Similar results have also been reported for blooming period, flower size, flower quality and other post harvest attribute as an influenced by macro nutrients [11]; [7] and [18].

Table 2: Effect of exogenous application of Humic acid and NPK on flower quality Tulip

Treatments		Scape length (cm)	Stem curvature (%)	Fresh weight (g)	Water uptake (cm^3)	Tepal diameter (mm)	No. of Petals wilting
5 days Interval	**T0**	23.12 b	86.15 d	21.45 c	43.74 d	5.65 c	2.67 b
	T1	24.45 b	47.45 c	22.56 c	52.34 c	6.06 bc	2.12 b
	T2	24.78 b	43.67 c	24.89 bc	54.31 bc	7 b	2.32 b
	T3	27.67 ab	31.41 bc	27.58 b	58.67 b	7.65 b	1.17 ab
	T4	29.34 a	21.78 b	29.43 ab	63.1 a	9.39 a	1.49 ab
	T5	30.95 a	17.23 a	33.21 a	66.95 a	10.34 a	0.23 a
10 days Interval	**T0**	27.54 b	91 e	25.25 d	35.8 d	6.28 c	5.45 c
	T1	26.36 b	53.34 c	26.06 cd	44.7 c	6.64 c	5.78 c
	T2	27.69 b	49.65 bc	28.51 c	46.54 bc	7.33 b	4.89 bc
	T3	30.11 ab	34.87 b	31.76 bc	52.43 b	8.03 b	3.34 b
	T4	32.75 a	26 ab	34.67 b	57.25 ab	10.51 a	2.56 ab
	T5	34.12 a	19 a	38.32 a	62.87 a	11.89 a	1.23 a

Role of humic acid and NPK on vase life and reduction in petal senescence

More emphasis has been given towards flower quality in the cut flower industry and Vase life is an important attribute which is directly participating in commercial marketing and economic aspect for flower genotype. This study revealed that combine application of HA and NPK played magnificent role in delayed the senescence process, strengthen to prolong the post harvest life of cut tulips. Results indicated that maximum vase life (11.70 days) was achieved when fed the plants with 75 ml/l Humic acid + 10 g/l NPK as marked with T_5. And those plants which received the dose in the form of T_4, T_3, T_2 and T_1 statistically extended the vase life for 10.83, 10.12, 8.45 and 8.17 days respectively. Least vase life (6.31 days) was observed in T_0 treatment which comprised with distilled water only and all observations recorded at two intervals (I^{st} at: 5 days, 2^{nd} at: 10 days). Ethylene is a plant hormone which causes the flower senescence and premature wilting and drooping of flowers. If flowers are treated with energetic vase solutions and proper supplements, Cut flower life and longevity will be improved without any barrier. So HA and NPK had the preservative role in the vase life extension by a reduction in ethylene synthesis rate reported by several authors. [19] and [2] proved that vase life increased up to 15 days with superior effect of 50ml/l humic acid level in different cultivars of Gerbera cut flower. Same vase life objectives were achieved by [22] in the different pulsing treatment of organic based HA in bedding plants. Humic acid and NPK are the substances which have auxin- like activity enhanced nutrient uptake which may be responsible for the good floral growth and vase life [21; [12]; [14] and [31].

Table 3: Effect of exogenous application of Humic acid and NPK vase life of cut Tulip

Treatments	Vase life (Days)
T0	6.31d
T1	8.17c
T2	8.45c
T3	10.12ab
T4	10.83ab
T5	11.70a

Observed flower bud diameter **Observed stalk length**

Figure-1: Some Post harvest activities in lab.

CONCLUSION

On the basis of above mentioned results, it can be concluded that humic acid and NPK are excellent preservative solutions which have the significant post harvest effect for cut flowers. This study declares that humic substances played a major role in plant physiological process and possess auxin-like hormonal activity being an integral part of reproductive growth. Application of HA in combination with NPK nutrients improved the post harvest life of cut tulip flowers. Pulsing treatment with a high concentration of HA (75 ml^{-1}) with 10 gram macro nutrients enhanced the scape length, fresh weight, bud diameter, flower longevity and vase life attributes as compared to control one. Furthermore, flower senescence and premature wilting have also been reduced significantly.

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