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IMPACTS OF IRRIGATION FREQUENCIES AND WEED CONTROL, IN FIELD GROWN TUBEROSES, IN THE WESTERN REGION OF SAUDI ARABIA: I. FLOWERING STALK YIELD, CLUMP GROWTH, ECONOMIC FEASIBILITY AND PROFITABILITY POTENTIAL

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ABSTRACT

A split-split-plot field experiment, in Complete Randomized Block Design, with four replicates, was conducted, in The Saudi Arabian Western Region Arid Zone, to investigate the impacts of different irrigation regimes; irrigation every 2, 4, 6 and 8 days, comprising the whole plots; manual hand weeding (unweeded control, weeding every 4, 8, and 12 weeks) representing the sub-plots and herbicidal treatments (control, pendimethalin, glyphosate and pendimethalin plus glyphosate) allocated for the sub-sub-plots, on tuberose yield, flowering, clump growth, economic feasibility and profitability potential, during the 2001/2002 and 2002/2003 growing seasons.

Frequent irrigation every two and/or four days immensely increased tuberose cut flower yield, noticeably extended the blooming period and markedly increased clump diameters & circumferences, in comparison to irrigation every six or eight days, in both seasons. Irrigation every four and/or six days markedly increased tuberose flowering-stalk- yield water use efficiencies, either as number and/or as unit fresh weight. Although irrigation every two and/or four days were considerably costly, it greatly increased gross returns, net profit, output/input ratio, and net profit/input ratio.

Weeding every four weeks greatly increased cut flower yield, extended the flowering period, in comparison to the untreated control or other weeding treatments. It also registered the highest gross returns, net profit, output/input ratio, and net profit/input ratio, although it was significantly costly.

Incorporating pre- and postemergence herbicides (pendimethalin plus glyphosate) profoundly improved tuberose cut flower yield, lengthened the blooming period, enlarged clump masses, and increased water use efficiencies. It also yielded the greatest economic feasibility indices, although it was relatively pricey.

Amalgamating pendimethalin plus glyphosate, at any level of hand weeding subjected to frequent irrigation every two and/or four days markedly improved tuberose flowering stalk yield and clump development. It also maximized gross returns, net profit and other economic feasibility parameters.

Frequent hand weeding was considerably costly, laborious, arduous, back breaking and time consuming in comparison to cheaper, easier and more effective use of herbicides, in field grown tuberoses.However, integrated weed control management with frequent irrigation every two and/or four days is economically feasible and potentially profitable.

Additional Index Words: Tuberose, Polianthes tuberosa, L., Irrigation Frequency, Hand Weeding, Herbicides, Flowering, Water Use Efficiency, Economic Feasibility.
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INTRODUCTION

Historically, tuberose plant (*Polianthes tuberosa, L.*), which belongs to family *Agavaceae* rather than family *Amaryllidaceae* (Shen, 1989), was highly prized by the Aztecs, who loved their fragrance and would use the plants in their rituals and ceremonies, where they held them sacred to their god of art and love. Tuberose made its way to Europe in the mid-1500s after the Aztecs were conquered by Cortez. By the late 1800s, it had become one of the most popular of all Victorian blossoms. It is grown nowadays on a wide scale in France for use in the perfume industry (Owens, 2003). Tuberose has long been cherished for its aromatic essential oil extracted from its fragrant-ivory-white flowers. It is also a popular cut flower, not only for use in floral arrangements, but also for the individual florets that can provide pleasant fragrance to bouquets, boutonnieres, garlands, wreaths, corsages, hair decorations and it also serves on several political, official, domestic and religious occasions (Singh, 1995 and Reid, 1996). Tuberose plants are also grown, in the Mediterranean region, for landscape gardening, rock gardens, roadsides and high way beautification purposes. Tuberose flowering spikes as well as the underground propagating materials are also sold in garden centers; nurseries and they are exported overseas (EL-Naggar, 1999). A survey made by the International Trade Center UNCTAD/GATT, Geneva, indicated that tuberose, as a cut flower, has tremendous demand from all over the world as well as the European countries, especially Belgium, France and the United Kingdom (Anonymous, 1987; Armitage and Laushman 1990 and Singh 1995). Many countries including Kenya, India and Mexico are growing tuberose commercially for export markets in the USA, Europe and Japan (Das *et al.*, 1988 and Reid, 1996). Tuberose is extremely important cut flower and bulb production crop in Nadia District (West Bengal), India, which is considered as one of the most prestigious growing centers allover the world according to Das *et al.*, (1988). The same authors

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attributed successful growth and great recognition of tuberose production to several economic reasons; 1- higher profitability per acre; 2- year round regular cash flow; 3- avoidance of risk of pilferage; 4- minimization of risk due to crop failure and price falls through crop diversification; 5- year round employment to disadvantaged individuals, such as widows, children and the handicapped. They also stated that, although initial investment for raising the crop is high, return per acre is much higher than other crops. Mitra *et al.,* (1989) and Mukherjee *et al.,* (2003) reported that tuberose cultivation is generally very profitable to the community of West Bengal, particularly Nadia District, and output/input ratio indicated the economic feasibility of tuberose cultivation in this District. However, loose flower production was found to be more remunerative compared to cut flower production.

Tuberose was introduced into the Saudi Arabian Western Region, as a new floricultural crop, in the last decade, aiming establishment, acclimatization and diversifying ornamental cut flower crop, in the area, and also targeting minimization of cut flower import from Egypt, Lebanon and neighboring countries (EL-Naggar and Byari, 1999 a, b, c and d). Successful establishment and acclimatization were obtained and comprehensive program(s) for improvement and ameliorations were initiated. A research program was then undertaken for irrigation water conservation and integrated weed management practices, to resolve irrigation water shed and the challenging associated weed problems, as major constrains and tribulation, in the area, where high temperatures exceeding 40s °C (Fig. A), are prevailing under the arid zone harsh environmental conditions, most of the year round (Anonymous, 2004; EL-Naggar and Byari, 2007 a, and b).

Increasing soil moisture content, through frequent irrigation and/or supplying efficient watering regime, is extremely important horticultural practice and is indispensable, not only for increasing cut flower yield, but also for improving underground subterrarian storing organs, in numerous bulbous ornamentals, according to EL-Naggar and Nassar (1994) on narcissus; Halepyati *et al.,* (2002) on tuberose; Maggio *et al.,* (1993); Bastug *et al.,* (2006) and Begum *et al.,* (2007) on gladiolus and Behdani *et al.,* (2008) on crocus (*Crocus sativus*). On the other hand, water stress and/or water deficit suppress photosynthetic activities, as well as almost all physiological processes in plants, resulting in impairing crop yield significantly, according to AL-Moftah and AL-Humid (2004) on tuberose and Wiwatpinyo and Detpiratmongkol (2008) on turmeric.

Weeds represent a major confronting challenge, in field-grown tuberoses, under furrow irrigation system, in the harsh environmental conditions of the Western Region of Saudi Arabia, which constraining and hampering ameliorations of tuberose cut flower yield and qualities as well as bulb production, in the area. Weeding and/or hoeing, as an old cultural practice, have long been used extensively, in field grown bulbous ornamentals, particularly in developing countries. It significantly minimize weed/crop competitions, improve cut flower yield and hasten underground storing organs according to Mohanty *et al.,* (2002); Panwar *et al.,* (2005 b) and EL-Naggar and Byari (2007 a) on tuberose; Misra and Verma (1997) and DongChun *et al.,* (2000) on gladiolus.

Many investigators working with bulbous ornamentals stressed the significant role and the importance of using the herbicidal chemicals solely or as a supplementary and auxiliary approaches in controlling weeds, rather than hand weeding alone, which is in comparison, rather costly, laborious, arduous and time consuming (Pal and Das, 1990 and Panwar *et al.,* 2005 a, on tuberose and Laskar and Jana, 1995 and Pushpalatha *et al.,* 2000, on gladiolus). Pendimethalin, as a preemergence herbicide, was found effective in controlling weeds, resulting in considerable increase in tuberose cut flower yield, according to Murthy and Narayana (1993). It also enhanced underground storing organs of elephant foot yam, according to Bhaumik *et al.,* (1988) and Ajai *et al.,* (2002) on turmeric (*Curcuma longa*). Glyphosate, however, as a postemergence herbicide, was also proven effective in enhancing tuberose cut flower yield characteristics and bulb development, according to Panwar *et al.,* (2005 b). Nevertheless, incorporating preemergence and post emergence herbicides, not only improved cut flower yield, according to EL-Naggar and Byari (2007 a) on tuberose; Seifert and Hott (1985) on tulip and Singh *et al.,* (2000) on gladiolus, but also enhanced corm growth and development of gladiolus plants according to Manuja *et al.,* (2005).

Studies concerning economic feasibility, due to weed control managements, in field grown bulbous ornamentals are very uncommon. However, most researches focused on dealing with economic edible vegetable crops. Akbar *et al.,* (1998) studied the profitability of tuberose cultivation in Godkhali and Panishar Unions of Jessore District, Bangladesh. They concluded that, tuberose cultivation has wider potential scope as a profitable crop. However, Pushpalatha *et al.,* (2000) addressed the high cost of labor in weeding gladiolus, although the high rate of return of 1.45 per rupee of investment showed economic feasibility of gladiolus cultivation. Rana *et al.,* (2004) found that, the cost of using herbicides was very much cheaper than hand weeding twice, resulting in high marginal benefit to cost ratio, of sweet potatoes. On the other hand, Tewari *et al.,* (1998) found that the greatest net monetary returns was obtained from hand weeding three times, followed by hand weeding plus pendimethalin, in field grown onion. However, Nadagouda *et al.,* (1996) found that, incorporating the preemergence herbicide pendimethalin with manual hand weeding together gave the highest net income and benefit to cost ratio in onion.

This study was initiated to investigate the impact of weed control management practices, under different irrigation frequencies, in the Western Region Arid Zone of Saudi Arabia, on tuberose cut flower, clump growth and water use efficiency as well as the economic feasibility and profitability potential.

MATERIALS AND METHODS

The concurrent investigation was conducted and executed at Hada AL-Sham's Agricultural Experimental Station, for Ornamental Plants Researches and Indoor Plant Propagation, of King Abdul-Aziz University, geographically located in Hada AL-Sham's valley, North East the City of Jeddah (Makkah AL-Mokaramah vicinity), during the growing seasons of 2001/2002, and 2002/2003.

A split-split-plot field experiment, in Complete Randomized Block Design, in four replicates, with 1.5 x 2 meter experimental plot (experimental unit), was conducted, under different irrigation frequency regimes, to resolve these nagging problems; irrigation frequencies (irrigation every 2, 4, 6 and 8 days) comprising the whole plots; manual hand weeding (unweeded control, weeding every 4, 8, and 12 weeks) represented the sub-plots and Herbicidal treatments (control, Pendimethalin, glyphosate and Pendimethalin plus glyphosate) in the sub-sub-plots. Detailed materials, methods and experimental procedures, however, were documented by El-Naggar and Byari 2007 a & b.

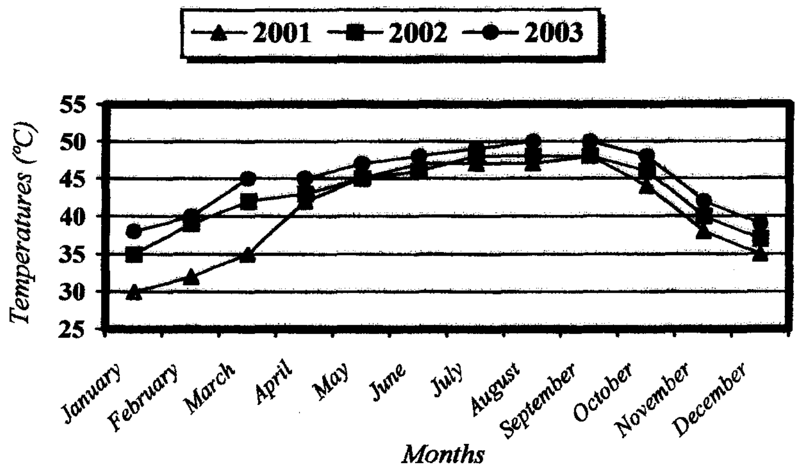

Fig. A: Maximum Monthly Temperatures (°C), at Hada Al-Sham's Agriculture Experiment Station (Makkah AL-Mokaramah Area, KSA), Over Three Consecutive Gregorian Years of 2001,2002 and 2003.

Tuberose bulbs ranging sizes (3.5 – 4.5 cm) in diameter, and 38-55 g average weights, were subjected to planting on April 28th, 2001/2002, and April 30th in the 2002/2003, growing seasons, respectively. Bulbs were planted according to the anticipated statistical design and layout of the split-split-plot design. All experimental plots were fertilized with the 5-10-5 complete fertilizers, at the rate of 200 kg/ha, in two split doses. The first dose was given 45 days after planting, while the second one was applied after 90 days, in both seasons. Each experimental unit (sub-sub-plot) was planted with 24 tuberose bulbs (4 rows x 6 columns), at distances of 25 x 30 cm. All experimental plots were treated with Carpofuran granules against termites (the area is colonialized with termite colonies), which dangerously attack any tender or succulent materials, in the area, such as roots, bulbs, tubers...etc.

Irrigation Frequencies / Watering Intervals

Irrigation frequency treatments were randomly assigned to the whole plots, which received certain amount of water, delivered through main, sub-main and sub-sub-main plastic pipes. Four 10-ton capacity tanks were installed and devoted for the execution of this investigation, one tank per two replicates (the experiment included four replicates). These four tanks were always maintained full of available water all times for the irrigation water treatments. A-4.5 horsepower water pump was also installed to deliver water in main, sub-main, and sub-sub-main pipes and tubes, in six-par active pressure, to the experimental plots, from these tanks. Irrigation treatments; every two, four, six and eight days were planned as to supply certain amount of water, through control points and gauges meters, calculated to reach the field capacity, for each specified experimental whole unit, assuming that the depth of the root zone distribution of tuberose plant is 30 cm depth. Each experimental whole plot in the experiment, included 16 experimental units (plots), which occupied an area of 48 m^2, required 3.00 m^3 of irrigation water, to reach field capacity, supplied by the fiberglass tanks, and were equivalent to 3000 liter/whole plot. Nevertheless, irrigation water quantities and amount, supplied through the tank suppliers and according to the measuring meter gauges readings, upon termination of the experiment, registered 703.00, 352.5, 235.08, and 172.87 cubic meter of water per whole plot, in correspondence with irrigation every 2, 4, 6 and 8 days on sequence, for the entire blooming period, which took about 16 months, due to continual blooming under the favorable prevailing conditions. However, the experiment was terminated intentially when blooming became noticeably light. However, irrigation treatments (watering intervals) scheduling were started after two months from the initial bulb planting. Tuberose bulbs were, however, watered, during this period, through furrow irrigation from bulb planting until complete emergence and plant establishment took place.

Weed Control Treatments

Manual hand weeding and hoeing

Four farm workers performed manual hand weeding operations, according to preplanned schedule and timetable, for the assigned sub-plots treatments; control or check (sub-plots left unweeded), sub-plots weeded every four weeks, sub-plots weeded every eight weeks, and sub-plots weeded every twelve weeks.

Herbicidal Treatments

Pendimethalin

Pendimethalin, *(N- (1-ethylpropyl)-3,4-dimethyl-2, 6-dinitro-benzeneamine* (C_{13} H_{19} N_3 O_4)), is manufactured by BASF Corporation, Agricultural Products Group, P. O. Box 13528, 26 Davis drive, Research Triangle Park, NC 27709, USA. It was bought from an agricultural establishment in Jeddah, Saudi Arabia with the trade name Pendulum® WDG (water dispersible granules), 60 % active ingredients. It was used at the rate of 2.0 kg a. i. /ha, as a dry flowable formulation (0.128 kg pendimethalin/ 10 liter water to cover area of 384 m^2 as specified and labeled sub-sub-plots for treatments), five days after bulb planting. Pendimethalin granules were properly mixed with about 5.00 liter of water and this diluted mixture was slowly added into a Ten-liter high-pressure hand sprayer tank. However, the remainder of the tank was carefully filled with water, with continuous agitation. Nonetheless, during pendimethalin application, agitation was occasionally performed to ensure excellent mixing. Moreover, thorough agitation was also performed to resusspend the mixture before spraying is resumed, when the spray mixture was allowed to settle, during indicating the labeled specified sub-sub-plots, according to the experimental design and layout.

Glyphosate

Glyphosate, N- (phosphonomethyl) glycine, C_3 H_8 NO_5 P, or Round up Ultra Max (60 % WSC) was used in this investigation. It is manufactured by Monsanto, Co., (800 N Lindbergh Blvd. St. Louis, Mo 63167, USA). It is used at the rate of 1.0 % a. i. /ha, in this experiment, and applied 60 days from initial bulb planting, as post emergence treatment, to the assigned sub-sub plots. However, dry ammonium sulphate at the rate of 2.0 % (by weight) was added to the spray solution to improve water quality of Hada Al-Sham.

Pendimethalin + Glyphosate

According to experimental design and the layout, sub-sub-plots assigned for the combined treatments of pendimethalin and glyphosate were treated with both herbicides as preemergence Pendimethalin, 2 kg a. i. /ha, (5 days from planting) and round up as postemergence, 1.0 a.i % /ha, (two months from planting).

Measurements and Data Recorded

Tuberose Cut Spikes & Bulb Production

Tuberose cut spike yield produced per sub-sub-plot, throughout the whole growing season was recorded. Flowering time was estimated from the initial planting, until intention termination of the experiment after about 16 months, was performed as weighted means. Clump diameters were measured; clump circumference was also estimated ($2\ \pi$ x clump diam/2). However, water use efficiencies, either as number of cut spikes produced per sub-sub-plot, or as yield unit fresh weight per sub-sub-plot per each cubic meter of water consumed, were also calculated.

Economic Feasibility & Benefits Indices

Tuberose cut spike yield, as the main product, was distributed, regularly, to wholesalers and flower shops, in bunches of 10's, at the rate of 5.00 S.R (Saudi Ryal) per spike. Tuberose clumps produced as secondary products, were also sold, to wholesalers, as well as to interested farmers and/or growers, according to categorical sizes and clump diameters; extra large (> 12.00 cm) = 8.0 S.R/clump; large (10.00-12.00 cm) = 6.00 S.R; medium (8.00-10 cm) = 4.00 S.R and small clumps (< 8.00 cm) = 2.00 S.R. However, total cost (including fixed and variable costs), gross returns (main product plus secondary product), net profits, benefits/cost ratio, cost/benefits ratio and net profits/cost ratio were calculated for each sub-sub-plot, and then subjected to statistical analyses.

Economic Feasibility & Benefits Cost Rates & Resources

- Planting Material Cost

Excellent quality tuberose mother clumps were imported at the rate of 2.00 EGP per clump (equivalent to 1.33 Saudi Ryal /piece). Each clump included 2-3 good quality tuberose bulbs (3.5-4.5 cm in diameter). Twelve clumps yielded at least 24 cultivable bulbs, specified for each sub-sub-plot (cost 15.96 S.R), after bulb and bulblets separation. However, the remainders of bulbs and/or bulblets were subjected to raising and breeding programs.

The experimental site of this investigation occupied an area of about 1250 m^2, and the cost for alternative opportunity for rental were estimated as 1000 S. R. /year, constituting 3.9 S. R. per each experimental sub-sub-plot (3 m^2).

- Water Irrigation Frequency Cost

Water irrigation frequency management and scheduling operations required a supervisor with monthly salary of 600 S.R. for the whole course of the irrigation scheduling investigation of about 15 months. This was sum up to yield 9000.00 S.R., which cost each sub-sub-plot experimental plot about 35.16 S. R.

Four fiberglass tankers of 10-ton water holding capacity were initially installed for the experimental project costing 2000 S. R. plus a 4.5 horsepower water pump for delivering water into the tankers, costing 750 S. R.. However, 32 gauge meters were required (14.00 S. R/piece) cost of 448 S. R. plastic hoses and tubes cost about 250 S. R. Additionally, fertilizers and Carpofuran for fighting termites cost 250 S.R. These capital and other expenses constituted a share of 14.45 S.R, for each experimental unit (sub-sub-plot of 3 m^2). The total cost of water consumed for tuberose irrigation frequency treatments, for the whole growing season, can be deduced or inferred from data demonstrated on Table (A. 1).

Table. A. 1. Total cost of irrigation water required for the whole course of the investigation for each irrigated sub-sub-plot (3 m^2) in S.R.

Irrigation frequency (Days)	Total water consumed (m^3)/whole plot	Alternative opportunity cost of water (23 m^3=117 S.R)	Total cost of water consumed (S.R) /whole plot	Total cost of water per sub-sub-plot (S.R)
2 D	703.00	30.57	3576.69	223.54
4 D	352.50	15.33	1793.61	112.10
6 D	235.08	10.22	1195.74	74.73
8 D	172.87	07.52	0879.84	54.99

- Weeding and Labor Cost

Total labor cost required for hand weeding, for tuberose experiment, during the whole investigation, employing 4 farm workers, at a rate of 20 S.R/worker/day are shown on Table (A. 2).

Table. A. 2. Total cost of hand weeding required for the whole course of the investigation for each weeded sub-sub-plot (3 m^2) in S.R.

Hand weeding (Weeks)	Weeding frequencies (#) x workers x salary	Total cost of weeding (S.R) / whole plots	Total cost per sub-sub-plot (3 m^2) (S.R)
Unweeded	----	----	----
4	16 x 80	1280	20.00
8	8 x 80	640	10.00
12	5 x 80	400	6.25

- Herbicidal Treatments Cost

Pendimethalin

256 gms of pendimethalin were required, at the rate of 2.00 kg/ha, for application to the specified sub-sub-plots. The 256 gms were used in a 10-Liter tank sprayer, two times, as 128 gms per tank-sprayer.

These 256 gms represented 0.1138 of the 5.00 lb pendimethalin package (cost 300 S.R). The total cost of pendimethalin application revealed 34.00 S.R. for the whole experiment, which were equivalent to 0.53 S.R for each specified sub-sub-plot.

Glyphosate

Two hundred cubic centimeter of glyphosate were used in filling a 10-liter tank sprayer, at a rate of 1.0 %, two times, as 100 cc per tank each time. The total cost for a glyphosate gallon (3750 cc) was 350.00 S.R. Accordingly, the total cost for glyphosate application for the whole experiment was 17.5 S. R, which was equivalent to 0.27 S. R for each treated sub-sub-plot.

Harvesting and handling tuberose cut flowers as well as bulb production required a labor worker for the whole period of investigation with wage of 500 S. R. on monthly basis. This, however, add up cost 7500 S. R., and the sub-sub-plot experimental unit ($3m^2$) share was 29.30 S. R., for these expenses.

Statistical analyses

Statistical analyses were performed using the General Linear Model (*GLM*) procedure, along with the regular analysis of variance, SAS computer package (version 8), and MSTAT computer program (SAS, 1999; Steel and Torrey, 1980 and Freed *et al.*, 1985). Orthogonal polynomial regression analyses, using polynomial coefficients (Gomez and Gomez, 1984), were performed to describe response curves (linear, quadratic and cubic) of tuberose plants different traits, using the Sigma Plot Scientific Graphing System (SPSGS). Correlation analyses were also performed between such investigated factor(s) versus measured traits, and among different parameters.

RESULTS AND DISCUSSIONS

Impact of Irrigation Frequencies

Irrigation, in general, is indispensable horticultural practices, particularly to flowering bulbous ornamentals. Irrigation frequencies or watering intervals strongly influenced tuberose cut flower yield, clump growth characteristics and water use efficiencies, in field grown tuberoses (Table 1).

Tuberose Cut Flower Yield

Irrigation frequencies immensely affected tuberose cut flower yield and blooming behavior, under the Western Region Arid Zone of Saudi Arabia, in two consecutive growing seasons. Frequently irrigated sub-sub-plots, irrigated every two days yielded the highest cut flower yield, in comparison to irrigation every four, six and/or eight days, in both seasons. However, there was notably strong statistical reduction, in tuberose cut flower yield production, coincide with reducing irrigation frequencies or increasing watering intervals. Irrigation every two and/or four days was noticeably superior, in producing abundantly much higher tuberose flowering stalk yield (55.35 and 60.45), and (36.42 and 46.48), in the two growing seasons, respectively, when compared to those produced by irrigation every six (28.63 and 34.06) and eight (18.44 and 21.25) days, in the two growing seasons, respectively. These behaviors and performances are well described by the strong negative linear polynomial regression, with one single degree of freedom, with high coefficients of determinations (Fig. 1). Comperhensive frequent irrigation, every two days, seems to provide tuberose plants with the ideal soil water moisture, around tuberose rhizosphere, facilitating minerals and nutrient's availabilities and absorptions by tuberose root system. This might, perhaps, have been reflected, indirectly, and translated into vigorous growth and noticeable productivities. These results are in great agreement with results obtained by EL-Naggar and Nassar (1994) on Narcissus; Halepyati *et al.*, (2002) on tuberose; Bastug *et al.*, (2006) and Begum *et al.*, (2007) on gladiolus plants. On the other hand, however, the relative increases in watering intervals might perhaps created sort of soil water deficit and imposed water stresses, on tuberose plants, restricting somehow growth and productivities. AL-Moftah and AL-Humid (2004) on tuberose and Wiwatpinyo and Detpiratmongkol (2008) on turmeric, reported that, lower water amounts and severe water stresses decreased stomatal frequencies and conductance, leaf water potential, osmotic potential, turger potential, relative water content, chlorophyll content, carbon assimilation rate, transpiration rate and subsequently decreased photosynthetic activities. This might explain the deteriorating performance of tuberose cut flower yield production, due to widening watering intervals and reducing irrigation frequencies.

Flowering Time & Blooming Period Behavior

Irrigation every two days delayed flowering and extended blooming period of tuberose plants up to 449.64 and 431.52 days, in both seasons, respectively, in comparison with irrigation every four, six or eight days (Table 1). There were also strong significant differences in tuberose blooming period, due to the different irrigation frequency treatments. Frequent irrigation every two days strappingly delayed flowering by 55.07, 73.01 and 112.50 days, when compared to irrigation every four, six and/or eight days, respectively, in the first growing season. However, it was 45.23, 67.77 and 83.54 days in the second one. It is worth notable that, frequent irrigation every eight days considerably shortened the blooming period of tuberose, in both seasons. Orthogonal polynomial regression analyses, with best curve fitting, evidentially illustrated these behaviors by strong linear pattern, with high coefficient of determinations (Fig. 1). High available water and moisture content provided by irrigation every two or even four days might be responsible for the continual growth and extending blooming of tuberose. Moreover, the high ambient temperature prevailing in the Western Region Arid Zone (Fig. A) might have also furnished ideal environment for tuberose growth and florishment. Armitage and Laushman (1990) and Yuniarti *et al.*, (1998) indicated that, the optimum growth of tuberose plants occurred at 21 °C or above and that high temperatures were extremely necessary for flower initiation, organogenesis, and flower maturation in tuberose. They also concluded that, tuberose can be produced as perennial and production does not significantly decline for at least three years, under Athene-Georgia conditions. El-Naggar and Byari (1999 a) obtained similar results, for tuberose, under the Western Region Arid Zone of Saudi Arabia. AL-Moftah and AL-Humid (2005) also reported that, the flowering period of tuberose plants was markedly shortened under water stress conditions imposed by 60 and 80% evapotranspiration (ET), in Kaseem area of the Eastern Region of Saudi Arabia.

Tuberose Clump Diameter and Circumference

Narrowing intervals between irrigations immensely increased tuberose clump diameter and circumference (Table 1), in comparison to expanding watering intervals. Frequent irrigation every two or four days greatly enlarged clump diameter and widened its circumference. In contrast, frequent irrigation every six and/or eight days intensely restricted clump development, producing the lowest clump diameter and circumference, in the two growing seasons. The quadratic and the cubic polynomial regression, statistically support these results. This favorable clump performance and enlargements due to frequent irrigation might be attributed mainly to high available soil moisture supplying abundance of minerals and nutrients to the developing tuberose plants, which, in turns, indirectly translated into excessive photosynthates deposited into tuberose sink storing organs. Many floricultural researchers well documented the favorable effects of frequent irrigations on underground storing organs of many bulbous ornamentals; Maggio *et al.*, (1993) on gladiolus; EL-Naggar and Nassar (1994) on Narcissus; Halepyati *et al.*, (2002) on tuberose; Zehan *et al.*, (2006) and Behdani *et al.*, (2008) on crocus. Inversely, unfavorable performance for tuberose clump diameter and/or circumference, due to frequent irrigation every six or eight days might be attributed to relatively low photosynthetic activities as well as low dry matter accumulation as a results of imposed water stresses according to AL-Moftah and Al-Humid (2004) on tuberose and Wiwatpinyo and Detpiratmongkol (2008) on turmeric.

Tuberose Water Use Efficiencies

Water Use efficiencies (Table 1), whether estimated as number of flowering stalks or as unit fresh weight of tuberose cut flower yield, produced per sub-sub-plot (3 m^2) by each cubic meter of water consumed, were profoundly affected by the different irrigation frequency treatments. Frequent irrigation every six days revealed the highest water use efficiencies, in the two growing seasons, followed by irrigation every four days, in comparison to other irrigation frequency treatments. Orthogonal polynomial regression analyses, broken down into one single degree of freedom, also revealed considerable quadratic and cubic performances. These performances are well described through regression curve fitting with high coefficient of determinations, in both seasons (Fig. 1), supporting the preceding results. However, the efficiency of water used by either six or four days irrigation intervals, for each cubic meter of consumed water might be attributed to ideally optimum water amount and/or quantity just enough to meet tuberose requirements. Nevertheless, excessive irrigation water and water use, manipulated during irrigation every two days, might have been subjected to evapotranspiration and/or leaching, through the soil system, after that tuberose plants had just taken its ideally required needs. Moreover, irrigation every eight days may be relatively stressful and that wider watering interval does not provide tuberose plants with optimum required water for plants continual growth and development. Alvino *et al.*, (1998) obtained similar supporting results on gladiolus plants. Halepyati *et al.*, (2002) also reported that, water use efficiency was highest with irrigation given to replenish 50 % E Pan, when compared to 100 % replenishment, during the vegetative and reproductive period of tuberose growth and development.

Economic Feasibility and Profitability Potential

Data provided in Table (2) demonstrate economic feasibility parameters, in S. R. per sub-sub-plot, for the salable tuberose cut flower yield, as the main product, and tuberose clumps, as the secondary product, produced as resulting products due to the effects of integrated weed control managements, under different irrigation frequency regimes, for two consecutive growing seasons, at Hada AL-Sham's Agricultural Experimental Station (Makkah AL-Mokaramah Area, KSA).

Total input and cost per 3 m^2 were greatly influenced by the different irrigation frequency regimes, in both seasons. Frequent irrigation every two days was considerably costly when compared to irrigation every four, six, or eight days, in the two growing seasons. However, there were gradual decreases and obvious reduction in total input or cost coincides with the different scheduled watering regimes. This might be due to the absolute irrigation cost or input for irrigated sub-sub-plots, which were 55.89, 28.03, 18.68 and 13.75 S. R., as alternative opportunity cost, in both seasons, for irrigation every two, four, six and eight days, respectively (Table A. 1).

Frequent irrigation every two days, however, required high quantity of irrigation water, which is naturally cost more input, in comparison to other irrigation treatments. Consequently, as the frequency of irrigation decreases, water cost and input decreases accordingly, and vise versa. These relationships are well depicted in Fig. (2) and described by the quadratic polynomial regression (R^2 = 1). Begum *et al.*, (2007), working on gladiolus, found that, the highest total water expense (TWE) received from plants receiving the highest water quantity compared with non-irrigated plants. The highest water expense efficiency (WEE) was obtained from the non-irrigated control.

High frequent irrigation, represented by irrigation every two and/or four days, and low frequent irrigation imposed by six or eight days watering intervals remarkably influenced the different economic feasibility indices, in both seasons (Table 2). Salable tuberose cut flower yield asw well as the associated clumps produced by sub-sub-plots, frequently irrigated every two and/or four days, immensely recorded the highest gross returns (output), net profit, output/input ratio, and net profit/input ratio, in the two growing seasons, in comparison with salable products produced by sub-sub-plots irrigated every six or eight days. These performances are well demonstrated and ascribed by polynomial regression statistical analyses, revealing either linear or quadratic behavioral regression, for each specified parameter or trait, associated with high coefficient of determinations (Fig. 2). Nevertheless, these performances may be attributed to such remarkable production of tuberose cut flower yield associated with wider clumps produced by frequent irrigations every two and/or four days, in comparison to those produced in sub-sub-plots frequently watered every six and/or eight days. Das *et al.* (1988); Mitra *et al.*, (1989) and Mukherjee *et al.*, (2003), well emphasized the economic feasibility and profitability of tuberose in India, particularly in Nadia District, although the initial investments is considerably high.

Impact of Manual Hand Weeding

Tuberose Cut Flower Yield & Blooming Behavior

Manual hand weeding, as a traditionally common horticultural practice, had strong profound impacts on tuberose cut flower yield and flowering performances (Table 1). Frequent hand weeding every four weeks markedly increased number of flowering stalks produced and expanded the blooming period considerably, in comparison with either unweeded control or even to those frequently weeded every eight or twelve weeks, in both seasons. However, frequent hand weeding every eight and/or twelve weeks registered significant favorable effects on tuberose cut flower yield and flowering behavior, when compared to the untreated control. Orthogonal polynomial regression analyses, broken down into one single degree of freedom, revealed either highly significant or significant linear, quadratic and cubic responses. Moreover, response curve fitting revealed noticeable cubic responses (Fig. 3), associated with high coefficient of determinations (*R^2 = 1.0*), for both parameters, in both seasons. Obviously, frequent hand weeding every four weeks, uprooting and removing weeds manually every four weeks, immensely restricted and hindered weed competition with tuberose plants, as the main crop. EL-Naggar and Byari (2007, a) found that, frequent hand weeding every four and/or eight weeks greatly reduced weed density, fresh and dry weights and noticeably increased weed control efficiencies, in comparison with the untreated control, in the two growing seasons. Alleviating weed competition, however, imply much more minerals and nutrients availabilities, soil moisture content, more space and solar energy. This, consequently, indirectly might have been translated into vigorous growth and plant development, producing more flowering stalks, expanding tuberose blooming period. Several investigators also reported that frequent weeding improved productivities of cut flower yields of numerous bulbous ornamentals; DongChun *et al.*, (2000) on gladiolus; Mohanty *et al.*, (2002) and Panwar *et al.*, (2005 b) on tuberose (*Polianthes tuberosa, L.*).

Tuberose Clump Diameter and Circumference

Data presented in Table 1, demonstrate tuberose clump growth and developmental features, as function of manual hand weeding, over two growing seasons. Frequent weeding every four weeks markedly enhanced clump growth, developing the widest clump diameterwise as well as circumferencewise, in both seasons, in comparison to unweeded controls. Recurrent weeding every eight or even every twelve weeks also noticeably enhanced clump growth and enlargements, in comparison to unweeded controls. However, there were significant differences among the different weeding treatments. Tuberose clump enlargemental behavior and developmental performances, as functions of the different weeding treatments, are graphically illustrated, through significant or highly significant orthogonal polynomial regression analyses, with curve best fitting and high coefficient of determinations (Fig. 3), sustaining the preceding results, for the two growing seasons. However, these performances as well as the noticeable increments in tuberose clump diameters and/or circumferences might be attributed to the stalwartly striking impacts of manual hand weeding on weed uprooting and removal (EL-Naggar and Byari, 2007a). Weed uprooting and/or removal in a manual manner may depend, however, on its frequencies. This might have permitted tuberose plants to take advantage of abundantly available minerals and nutrients in the soil solutions, high soil moisture content, wider space and ambient light & temperatures. This consequently might have lead to speed up growth rate, accelerating photosynthetic activities, resulting in profusion of photosynthates, deposited in tuberose sink subterranean storing organs. Floriculture researchers and investigators, interested in weed control, in grown bulbous ornamentals, reported that, frequent weeding considerably improved underground storing organs and hastened its developmental enlargement and performances: Misra and Verma (1997) on Gladiolus; Mohanty *et al.*, (2002): and Panwar *et al.,* (2005 b) on Tuberose and Santosa *et al.*, (2006) on Elephant Foot Yam (*Amorphophallus campanulatus*).

Water Use Efficiencies

The impact of manual hand weeding treatments on tuberose water use efficiencies, water status and availabilities are presented on Table (1). Water use efficiencies, in field grown tuberoses, whether it were calculated based on number of flowering stalks produced or even unit fresh weight of cut flower yield per experimental unit (3 m^2) per cubic meter of consumed irrigation water, were immensely influenced by different hand weeding treatments, in both seasons. Frequently weeded sub-sub-plots every four weeks noticeably provided tuberose plants with the highest water use efficiencies, during the two growing seasons, in comparison to unweeded controls. Frequent weeding every eight or twelve weeks also recorded highly significant differences, in comparison to the untreated controls, in both seasons. However, there were also substantial differences between weeding every eight and twelve weeks. Nevertheless, unweeded controls remarkably recorded the lowest water use efficiencies, in both seasons. Breaking down the highly significant impacts of the three hand weeding's degrees of freedom into only one single degree, revealed either significant or highly significant linear, quadratic and cubic responses, via orthogonal polynomial regression analyses. Graphical illustrations presented in Fig. 3, exhibited regression performances of tuberose water use efficiencies in obvious cubic patterns, through best curve fitting, associated with high coefficient of determination, in the two growing seasons, ascertaining previous results. The immense noticeable increases in water use efficiencies, for tuberose cut flower yield, as number or as weight, per sub-sub-plots, per cubic meter of irrigation water consumed, due to frequent weeding, particularly, every four weeks are evidently explicable by crop/weed competions complexity. EL-Naggar and Byari (2007 a), found that, frequent hand weeding, every four weeks, recorded the lowest weed's water use efficiencies, meanwhile unweeded controls registered the highest weed's water use efficiencies. Therefore, each cubic meter of water consumed in irrigating sub-sub-plots weeded frequently every four weeks was statistically competent in producing efficiently minimum weed densities and biomasses. This subsequently, gave rise to produce the highest cut flower yield in term of number and/or weight, as balancing results of weed/crop competitions. Inversely, each cubic meter of water consumed in watering unweeded controls was highly efficient in producing the highest weed densities and biomasses and poorly efficient to generate the lowest yield of tuberose flowering stalks. Berger *et al.*, (2007) stated that, water transpired by contending weeds could exacerbate crop drought stress, particularly in dry periods, through increasing soil moisture deficits, resulting in a decrease in crop water use efficiency. However, weed-crop competition for water is dynamic as water uptake depends on the relative growth stage of the crop versus the weed and plant stress status depends on the amount of solar radiation intercepted and the degree of depletion of soil water reserves.

Economic Feasibility & Profitability Potential

Economic feasibility parameters and indices as influenced by hand weeding frequencies are presented in Table (2). Frequent hand weeding every four weeks recorded the highest cost, whereas unweeded controls recorded the lowest. However, weeding every eight and/or twelve weeks also showed high cost, in comparison to the unweeded control (Table 2 & Table A. 2). Polynomial regression with curve best fitting described total input and cost of hand weeding, in cubic manners, indicating noticeable high cost due to frequent weeding every four weeks (Fig. 4). This, might be attributed to intensive frequent weeding requiring four workers each time of weeding, in comparison to other weeding frequency treatments. Minakschi and Mehta (2007) on Gladiolus; Soufizadeh *et al.*, (2007) and Alam (2007) on crocus also reported the high cost and/or input share, due to frequent weeding requiring labor, for controlling weeds, in field grown crocus (*Crocus sativus*). Experimental sub-sub-plots frequently weeded every four weeks immensely registered the highest gross income sales (output), net profit, output/input ratio, and net profit/input ratio, in comparison to unweeded controls or even other weeding frequency treatments, in both seasons. Nevertheless, weeding every eight and/or twelve weeks also considerably resulted in higher gross returns, profits, gross returns/cost ratio and net profits/cost ratio, in the two growing seasons, when compared to unweeded controls (Table 2). Nonetheless, weeding frequency every eight weeks was statistically beneficial when compared with those weeded every twelve weeks. However, orthogonal polynomial regression analyses, with curve best fitting, revealing either quadratic or cubic descriptive performances or behaviors, clearly ascertained previously discussed results. Obviously, weeding frequency, in general, particularly every four weeks was beneficially rewarding, economically feasible and potentially profitable, when compared to unweeded control. These evidently might be attributed to obvious and remarkable production of cut flower yield as well as vigorous tuberose clumps produced. Tewari *et al.*,

(1998) found that the greatest net monetary returns was obtained from hand weeding three times, followed by hand weeding plus pendimethalin, in field grown onion. Pushpalatha *et al.*, (2000) also found that, the greatest net profit/cost ratio (1.45) was obtained with hand weeding, revealing economic feasibility and profitability for gladiolus cultivation.

Impact of Herbicides

Tuberose Cut Flower Yield & Blooming Behavior

The noticeably strong impacts of the different herbicidal treatments; pendimethalin, glyphosate and pendimethalin plus glyphosate versus the untreated control, are presented in Table 1. Obviously, all herbicidal treatments profoundly affected tuberose cut flower yield and blooming period, in comparison to the untreated controls, in both seasons. Pendimethalin plus glyphosate immensely increased number of cut flower produced, per experimental unit. It also markedly lengthened the blooming period of tuberose, in comparison to untreated controls or even to each herbicide applied solely, in both seasons. This treatment, however, yielded more than double of tuberose flowering stalks (2.25 and 2.13), and noticeably expanded the blooming period by 49.02 and 61.70 days, in both seasons, respectively, when compared to the untreated controls. This treatment also not only improved yield of cut flowers significantly, when compared to those produced by the application of each herbicide separately, in both seasons, but also extended the blooming period. Orthogonal contrast statistical analyses revealed highly significant impacts for the different available ways of orthogonal comparisons, in both seasons, for cut flower productions and flowering behaviors. This consequently resulted in strongly powerful synergistic impacts of both herbicides. Each herbicide was significantly effective in controlling weeds versus untreated controls, which subsequently and indirectly was reflected on noticeable flowering production and behaviors. However, the existence of both preemergence and postemergence herbicides together, in one single treatment, exhibited powerful synergistic effects on producing the highest cut flower yield over noticeably longer period of florishment. These findings might be attributed, mainly, to the strong synergistic effects of herbicides on weeds and on hindering weed/crop competitions. Subsequently, tuberose plants might have taken great advantages of all available resources; minerals & nutrients, moisture, solar energy, spaces.... etc. EL-Naggar and Byari (2007 a) found that, pendimethalin plus glyphosate, as preemergence and postemergence herbicides together, greatly reduced weed density, weed's water use efficiencies, and noticeably increased weed control efficiency, in comparison to the untreated controls. They also found that, yield of tuberose cut flowers was negatively correlated with weed water use efficiencies and positively correlated with weed control efficiency, in both seasons. Seifert and Hott (1985) on tulip and Singh *et al.* (2000) on gladiolus, also indicated that, herbicidal mixing and/or incorporations, results in more than 90 % weed control, resulting in obvious favorable effects.

Tuberose Clump Diameter and Circumference

Tuberose clump diameter and circumference were profoundly influenced by the different herbicidal treatments (Table 1). All herbicidal treatments greatly improved clump development, when compared to the untreated controls, in both seasons. Pendimethalin plus glyphosate markedly enhanced tuberose clump diameters as well as its circumferences, in comparison to the untreated controls or to either herbicide when applied solely. However, each herbicide applied alone was also effective in enhancing tuberose clump diameters and circumferences, in comparison to untreated controls. Clump growth and development performances, due to applying pendimethalin plus glyphosate, in one single treatment, might be referred to the powerful mutual synergistic effects of both herbicides, in both seasons, as statistically revealed by the orthogonal contrast procedure. These profound impacts might be attributed mainly to the indirect effects on immense weed control efficiency as well as minimal weed water use efficiencies, in treated sub-sub-plots. These herbicidal behaviors might perhaps permitted tuberose plants to develop better, in non-competitive environment, resulting in conspicuous growth performances. Bhaumik *et al.*, (1988) on Elephant Foot Yam and Ajai *et al.*, (2002) on Turmeric, found that, pendimethalin application resulted in perceptible underground crop vigor. Panwar *et al.*, (2005 b) found that, glyphosate greatly enhanced tuberose bulb growth and development. Moreover, Manuja *et al.*, (2005) found that, glyphosate + pendimethalin markedly controlled weeds and improved corm development of gladiolus.

Water Use Efficiencies

Water use efficiencies, estimated as number or as unit fresh weight, of tuberose flowering stalks, produced by sub-sub-plots per each cubic meter of irrigation water consumed, were strongly influenced by preemergence and/or postemergence herbicides and their combination (Table 1). Sub-sub-plots that received pendimethalin plus glyphosate intensely increased tuberose water use efficiencies, in both seasons, in comparison to untreated controls or even to any of the applied herbicides. Orthogonal contrast, way of comparison procedure, depending on degrees of freedom, also revealed highly significant effects for all possible ways of contrasts. However, although pendimethalin or glyphosate was effective in improving water use efficiencies versus untreated controls, pendimethalin plus glyphosate was pronouncingly superior, resulting in the highest efficiency. This might be attributed to immensely strong impacts on controlling weeds, in anticipated sub-sub-plots, minimizing weed water use efficiencies. This subsequently might have allowed irrigation water specified to be highly efficient, in comparison to untreated controls or even to those treated with either pendimethalin or glyphosate. EL-Naggar and Byari (2007 a) found that, pendimethalin plus glyphosate treatment remarkably decreased weed water use efficiencies and profoundly increased weed control efficiency, when compared to the highest weed water use efficiencies and the considerably lowest weed control efficiency, in both seasons, of the untreated sub-sub-plots. The same authors also found that, there were highly significant positive relationships between flower yield and weed control efficiency, indicating that, tuberose cut flower yield would substantially increases simultaneously as the efficiency of weed control increases. However, they concluded that, combination of preemergence (pendimethalin) and postemergence (glyphosate) herbicides was very effective in controlling weeds, which subsequently provided tuberose plant with very beneficial nutritional environment.

Economic Feasibility & Profitability Potential

Economic feasibility parameters (Table 2) were strappingly influenced by the different herbicidal treatments; the preemergence pendimethalin alone, the postemergence glyphosate alone, and the combination of both herbicides versus the untreated control. The different herbicidal treatments were considerably costly when compared to the untreated control. However, pendimethalin plus glyphosate total cost were significantly higher than total cost spent in sub-sub-plots treated with either herbicide applied alone. The differences in total cost might be attributed mainly to herbicidal cost share per sub-sub-plot (0.53, 0.27 and 0.80 S. R.) for pendimethalin, glyphosate and pendimethalin plus glyphosate, respectively. Nevertheless, total cost share for all herbicidal treatments, for the whole experiment, per sub-sub-plot was estimated as 1.60 S. R., whereas total cost share of hand weeding was found to be 13.75 S. R., for the whole experiment (Table A. 2). This indicates that, the use of herbicides in controlling weeds was generally cheaper (11.64 %) than hand weeding, which was considerably costly (8.59 times greater), arduous, back breaking and time consuming. Similar findings were obtained by Pal and Das (1990) and Panwar *et al.*, (2005 a) on tuberose and Laskar and Jana (1995) and Pushpalatha *et al.*, (2000) on gladiolus. Tuberose cut flower yield sales, as the main products, in addition to that of subterranean clumps, as the secondary products, (gross returns or output) were immensely increased by the application of pendimethalin and glyphosate in comparison to the untreated controls or to each herbicide applied separately, in both seasons (Table 2). Application of glyphosate or pendimethalin, separately, also recorded considerably higher output or gross return, in comparison to the untreated control. Pendimethalin and glyphosate application, in one single treatment, also recorded the highest net profit, output/input ratio and net profit/input ratio, in the two growing seasons, in comparison to the untreated control or even to any of the applied herbicides. The beneficial impacts of any of the applied herbicides, particularly, pendimethalin plus glyphosate, may be attributed mainly to the enormously noticeable production of tuberose flowering stalks associated with obviously vigorous subterrarian clumps. This directly might have translated into high income and profits. Results of Rana *et al*., (2004) are in agreement with the preceding results.

Mutual Interactive Effects

Irrigation frequencies, manual hand weeding and the different herbicidal treatments interacted mutually together resulting in different non-significant, significant and/or highly significant interactive effects (Tables 3 & 4), for tuberose cut flower yield, clump growth and development and economic feasibility parameters, in the two growing seasons. Although the mutual interactive effects revealed different significant and/or highly significant second orders (two ways) effects, on the different traits and parameters, this manuscript would only focuses on discussing the third order interactions (three way interactions).

Irrigation frequencies x Manual hand Weeding x Herbicidal Treatments

Tuberose Cut Flower Yield

Tuberose cut flower yield performances, as influenced by the mutual interactive effects of irrigation frequencies, manual hand weeding and different herbicidal treatments, during the two growing seasons, are presented in Fig. (5). Obviously, yield of tuberose flowering stalks was profoundly improved in experimental units received pendimethalin, as a preemergence plus glyphosate as a postemergence herbicides, irrigated frequently every two or four days and weeded every four, eight and even twelve weeks. In contrast, experimental units non-treated with any herbicidal treatment at all, or those receiving only pendimethalin and weeded every eight or twelve weeks and subjected to stressful irrigation every six or eight days, adversely exhibited contrasting effects. The noticeable synergistic effects of pendimethalin plus glyphosate, both in one single treatment, along with efficient hand weeding in controlling weeds, particularly under watering frequencies of irrigation every two or four days might be responsible for the pronounced production of tuberose cut flower yield. However, the noticeable adverse effects may be due to experimental units characterized by poor weed control, poor soil water moisture content and nutrient availabilities. Results of EL-Naggar and Byari (2007 b) strongly support these results.

Tuberose Clump Growth and Development

Tuberose clump diameters were markedly enhanced in sub-sub-plots treated with pendimethalin plus glyphosate or with glyphosate, applied alone, frequently weeded every four, eight and even twelve weeks, and subjected to frequent irrigation every two days (Fig. 5), in both seasons. On the contrary, sub-sub-plots untreated at all with any herbicide, unweeded at all or weeded every eight and/or twelve weeks and subjected to stressful irrigation every eight days exhibited the poorest clump growth performances. The noticeable performances of tuberose clump growth might be attributed to the powerful effects of pendimethalin plus glyphosate and frequent manual hand weeding in controlling weeds efficiently , in anticipated sub-sub-plots, minimizing weed water use efficiencies, particularly under frequent watering and irrigation every two days. This subsequently provided tuberose plants with profusion of available soil moisture, rich in nutrients, more room and spaces, enhancing vegetative growth, photosynthetic activities and storing excess photosynthates in tuberose clumps. On the other hand, stressful conditions imposed by irrigation every eight days, generally, might have restricted all physiological processes, especially in sub-sub-plots characterized by extremely high weed/tuberose competitions.

Economic Feasibility & Profitability Potential

Economic feasibility parameters; gross return, net profit, output/input ratio, and net profit/input ratio of tuberose saleable products (flowering stalks and clumps) were strongly influenced by the mutual interactive effects of irrigation frequencies, hand weeding, and herbicidal treatments, in field grown tuberoses, over two growing seasons (Fig. 5 & 6). Great gross income & output, high net profit, noticeable output/input ratio, and considerable net profit/input ratio were statistically associated with experimental units received pendimethalin plus glyphosate, frequently weeded every four, eight or twelve weeks and subjected to irrigation every two or four days. In contrast, experimental units received pendimethalin, glyphosate or untreated at all, unweeded at all or even weeded at any level of weeding, and subjected to watering every eight days exhibited the poorest performances, resulting in low income as well as noticeably obvious economic infeasibilities. Highly recognized economic feasibility parameters associated with the anticipated experimental units might be attributed to high productivities of tuberose flowering stalks and vigorous clumps generating considerable income and obvious returns. On the other hand, poor income and sometimes negative returns for the anticipated experimental units may be referred to noticeably poor production of flowering stalk yield associated with poor clump development.

Pearson Correlation Analyses

Data presented on Table (5) demonstrate correlation coefficients of tuberose cut flower yield as well as tuberose clumps and water use efficiencies in relation with economic feasibility parameters and indices. It describes the nature and behavioral relationships among traits and parameters in statistical matrices. Tuberose cut flower yield was strongly correlated positively with water use efficiency, clump diameter, total input, output, net profit, output/input ratio, net profit/input ratio and negatively correlated with input/output ratio, in both seasons. This indicates that, as tuberose clump developmental diameter and water use efficiency increase, cut flower yield would increases accordingly. Besides, as total input or cost increases, due to intensive field operational practices and treatment applications, flowering stalk yield would also positively increases. This would be reflected on immense increases in output, net profit, output/input ratio and net profit/input ratio, subsequently. However, tuberose cut flower yield was negatively correlated with input/output ratio.

Water use efficiency was also considerably positively correlated with clump diameter, gross return, net profit, output/input ratio and net profit/input ratio. In contrast, it was negatively correlated with total input and input/output ratio. Obviously, as the efficiency of each single cubic meter of irrigation water increase, clump growth and development would also increases. Subsequently, gross return, net profit, output/input ratio and net profit/input ratio would increase. Inversely, as the efficiency of water increases, total cost as well as input/output ratio would immensely decrease and vise versa.

Tuberose clump diameter was also positively correlated with total cost (input), gross returns, net profit, output/input ratio and net profit/input ratio, but negatively correlated with input/output ratio. Clump growth and development would naturally increases considerably as a result of increasing cost of controlling weeds and watering practices. This accordingly would leads to increasing gross returns, net profit,, output/input ratio and net profit/input ratio. However, the ratio of input/output would subsequently decrease.

CONCLUSION & RECOMMENDATIONS

Conclusion & recommendations conferred from the present manuscript can be summarized in the following points:

1- Minimizing weed/tuberose competitions, for limited resources, such as light & solar energy, water & soil moisture, minerals and nutrients, resulted in considerable production of high yield of flowering stalks associated with vigorous subterrarian clumps.
2- Frequent irrigation is extremely indispensable for tuberose productivities and weed control management is considered as powerful

Table (1): Impacts of irrigation frequencies, hand weedings and herbicides on tuberose cut flower yield, flowering, clump characteristics and water use effeciencies, in field grown tuberoses (*Polianthes tuberosa, L. cv. "Double"*), during the 2001/02 and 2002/03 growing seasons, at Hada AL-Sham's Agricultural Experiment Station (Makkah AL-Mokarama Area, KSA).

Growth Parameters (Avg.) / sub-sub-plot (3.0 m^2)	Cut flower yield (#)		Flowering time (Days)		Clump diameter (cm)		Clump circumference (cm)		WUE (#)^Y		WUE (wt)^Z	
Treatments	2001/02	2002/03	2001/02	2002/03	2001/02	2002/03	2001/02	2002/03	2001/02	2002/03	2001/02	2002/03
• Irrigation frequencies (Days)^X												
Two	55.35 a	60.43 a	449.64 a	431.52 a	13.21 a	13.15 a	41.48 a	41.28 a	1.26 c	1.38 d	129.46 b	189.64 c
Four	36.42 b	46.48 b	394.57 b	386.29 b	10.27 b	09.92 b	32.24 b	31.16 b	1.66 b	2.11 b	158.64 a	229.27 b
Six	28.63 c	34.06 c	376.63 c	363.75 c	08.76 c	09.22 b	27.50 c	28.96 b	1.95 a	2.32 a	181.16 a	250.55 a
Eight	18.44 d	21.25 d	337.14 d	347.98 d	08.33 c	06.98 c	26.15 c	21.90 c	1.71 b	1.97 c	123.81 b	176.39 c
F-Test	**	**	**	**	**	**	**	**	**	**	**	**
LSD 0.05	3.37	2.95	13.24	13.69	1.00	1.03	03.15	3.23	0.16	0.13	23.14	14.82
0.01	4.84	4.24	19.02	19.66	1.44	1.48	04.53	4.64	0.24	0.18	33.25	21.29
Polynomial regression												
Linear	**	**	**	**	**	**	**	**	**	**	ns	*
Quadratic	**	ns	ns	**	**	ns	**	ns	**	**	**	**
Cubic	*	ns	**	ns	ns	*	ns	*	ns	ns	*	*
• Manual weeding (Weeks)												
Control	27.25 d	28.52 d	376.30 c	364.29 d	8.81 d	09.03 c	27.65 d	28.35 c	1.22 d	1.47 d	093.55 d	140.92 d
Four	42.50 a	53.15 a	403.66 a	400.54 a	11.26 a	10.43 a	35.34 a	32.75 a	2.07 a	2.53 a	204.33 a	291.18 a
Eight	37.90 b	42.68 b	394.09 b	389.69 a	10.56 b	10.28 a	33.15 b	32.27 a	1.81 b	2.03 b	164.96 b	228.95 b
Twelve	31.20 c	37.87 c	383.93 c	375.02 c	09.95 c	09.53 b	31.23 c	29.92 b	1.47 c	1.74 c	130.23 c	184.79 c
F-Test	**	**	**	**	**	**	**	**	**	**	**	**
LSD 0.05	2.91	2.99	07.76	5.85	0.30	0.32	0.95	1.02	0.14	0.13	18.37	17.85
0.01	3.90	4.01	10.41	7.85	0.41	0.43	1.28	1.36	0.18	0.18	25.30	23.94
Polynomial regression												
Linear	**	**	**	**	**	**	**	**	**	**	**	**
Quadratic	**	**	**	**	**	**	**	**	**	**	**	**
Cubic	*	**	**	*	*	*	*	*	*	**	**	**
• Herbicides												
Control	22.57 d	26.81 d	365.14 d	352.16 d	08.32 d	07.73 d	26.13 d	24.28 d	0.99 d	1.28 d	065.92 d	101.95 d
Pendimethalin	29.10 c	36.71 c	383.87 c	370.27 c	09.58 c	08.95 c	30.09 c	28.10 c	1.36 c	1.71 c	101.91 c	171.44 c
Glyphosate	36.35 b	41.68 b	394.81 b	393.26 b	10.90 b	10.26 b	34.27 b	32.22 b	1.75 b	1.98 b	165.18 b	218.94 b
Pendimethalin + Glyphosate	50.83 a	57.03 a	414.16 a	413.86 a	11.75 a	12.32 a	36.89 a	38.69 a	2.47 a	2.80 a	260.05 a	353.52 a
F-Test												
LSD 0.05	**	**	**	**	**	**	**	**	**	**	**	**
0.01	2.40	2.62	7.31	6.43	0.45	0.39	1.40	1.22	0.10	0.11	11.94	16.74
Orthogonal contrast	3.17	3.46	9.65	8.49	0.59	0.51	1.86	1.61	0.13	0.15	15.77	22.10
Control vs Others												
Pendi. vs Pendi. + Glyphosate	**	**	**	**	**	**	**	**	**	**	**	**
Gly. vs Pendi. + Glyphosate	**	**	**	**	**	**	**	**	**	**	**	**
	**	**	**	**	**	**	**	**	**	**	**	**

*, **, ns Significant, highly significant and not significant at the 0.05 and 0.01 levels of significance, according to the Least Significant Difference Test.
X Means with the same letters are not significantly different at the 0.05 level of significance, according to Fisher's Protected L.S.D Test of Significance.
Y & Z Water use efficiencies, estimated based on number or unit fresh weight of tuberose cut flower produced / sub-sub-plot (3 m^2) / each m^3 water consumed.

Table (2): Impacts of irrigation frequencies, hand weedings and herbicides on tuberose economic feasibility and profitability potential parameters & indicies, in field grown tuberoses (*Polianthes tuberosa, L. cv. "Double"*), during the 2001/02 and 2002/03 growing seasons, at Hada AL-Sham's Agricultural Experiment Station (Makkah AL-Mokarama Area, KSA).

Economic feasibility parameters (S.R.) /sub-sub-plot (3.0 m²)	Total input (cost) / (3m²)		Output (gross return) Y		Net profit/(3m²)		Output / input ratio		Input / output ratio		Net profit/input Ratio	
Treatments	2001/02	2002/03	2001/02	2002/03	2001/02	2002/03	2001/02	2002/03	2001/02	2002/03	2001/02	2002/03
• Irrigation frequencies (Days)X												
Two	153.21 a	153.21 a	406.33 a	430.16 a	253.12 a	276.96 a	2.65 a	2.80 a	0.40 d	0.39 c	1.65 a	1.80 a
Four	125.35 b	125.35 b	278.74 b	328.40 b	153.39 b	203.06 b	2.22 b	2.61 b	0.48 c	0.41 c	1.22 b	1.61 b
Six	116.03 c	116.03 c	208.54 c	234.29 c	092.51 c	118.30 c	1.79 c	2.01 c	0.64 b	0.54 b	0.79 c`	1.01 c
Eight	111.10 d	111.07 d	124.12 d	139.09 d	013.02 d	028.02 d	1.11 d	1.25 d	1.01 a	0.88 a	0.11 d	0.25 d
F-Test	**	**	**	**	**	**	**	**	**	**	**	**
LSD 0.05	0.07	0.0022	17.85	15.02	17.85	15.02	0.13	0.11	0.06	0.03	0.13	0.11
0.01	0.11	0.0032	25.64	21.52	25.65	21.58	0.19	0.15	0.09	0.04	0.19	0.15
Polynomial regression												
Linear	**	**	**	**	**	**	**	**	**	**	**	**
Quadratic	**	**	**	ns	ns	ns	**	**	**	**	**	**
Cubic	**	**	*	ns	*	ns	ns	ns	ns	*	ns	ns
• Manual weeding (Weeks)												
Control	122.97 d	122.97 d	218.46 c	223.43 d	095.49 d	100.46 d	1.79 d	1.79 d	0.72 a	0.63 a	0.79 d	0.79 d
Four	130.53 a	130.47 a	292.35 a	345.77 a	161.82 a	215.31 a	2.18 a	2.57 a	0.56 c	0.47 d	1.18 a	1.57 a
Eight	126.72 b	126.72 b	270.95 b	293.42 b	144.23 b	166.70 b	2.07 b	2.25 b	0.58 c	0.53 c	1.07 b	1.25 b
Twelve	125.47 c	125.47 c	235.97 c	269.34 c	140.50 c	143.89 c	1.82 c	2.07 c	0.68 b	0.59 b	0.82 c	1.07 c
F-Test	**	**	**	**	**	**	**	**	**	**	**	**
LSD 0.05	0.06	0.002	13.86	14.99	13.84	14.99	0.10	0.11	0.04	0.03	0.10	0.11
0.01	0.09	0.003	18.59	20.10	18.56	20.10	0.14	0.15	0.05	0.04	0.14	0.15
Polynomial regression												
Linear	**	**	**	**	**	**	**	**	*	**	**	**
Quadratic	**	**	**	**	**	**	**	**	**	**	**	**
Cubic	**	**	*	**	ns	**	ns	**	ns	**	ns	**
• Herbicides												
Control	126.04 d	126.01 d	194.12 d	213.97 d	068.08 d	087.96 d	1.47 d	1.65 d	0.82 a	0.71 a	0.47 d	0.65 d
Pendimethalin	126.53 b	126.54 b	226.17 c	264.45 c	099.63 c	137.91 c	1.72 c	2.02 c	0.69 b	0.58 b	0.72 c	1.02 c
Glyphosate	126.29 c	126.28 c	261.75 b	288.41 b	135.45 b	162.13 b	2.01 b	2.21 b	0.57 c	0.52 c	1.01 b	1.21 b
Pendimethalin + Glyphosate	126.82 a	126.81 a	335.69 a	365.13 a	208.87 a	238.33 a	2.57 a	2.80 a	0.45 d	0.41 d	1.57 a	1.80 a
F-Test	**	**	**	**	**	**	**	**	**	**	**	**
LSD 0.05	0.05	0.002	11.49	13.12	11.49	13.12	0.08	0.10	0.03	0.03	0.08	0.10
0.01	0.07	0.003	15.18	17.33	15.18	17.33	0.11	0.13	0.04	0.03	0.11	0.13
Orthogonal contrast												
Control vs Others	**	**	**	**	**	**	**	**	**	**	**	**
Pendi. vs Pendi. + Glyphosate	**	**	**	**	**	**	**	**	**	**	**	**
Gly. vs Pendi. + Glyphosate	**	**	**	**	**	**	**	**	**	**	**	**

*, **, ns *Significant, highly significant and not significant at the 0.05 and 0.01 levels of significance, according to the Least Significant Difference Test.*

X *Means with the same letters are not significantly different at the 0.05 level of significance, according to Fisher's Protected L.S.D Test of Significance.*

Y *Gross return (output) includes tuberose cut flower yield (flowering stalks), as a main product, and the bulbous clumps, as a secondary product.*

Table (3): Second and third order mutual interactive effects of irrigation frequencies, hand weeding, and herbicides on tuberose cut flower yield, flowering, clump characteristics and water use effeciencies, in field grown tuberoses (*Polianthes tuberosa, L.* cv. "Double"), during the 2001/02 and 2002/03 growing seasons, at Hada AL-Sham's Agricultural Experiment Station (Makkah AL-Mokarama Area, KSA).

Growth parameters (avg.)/sub-sub-plot	Cut flower yield (#)		Flowering time (Days)		Clump diam. (cm)		Clump circum. (cm)		WUE (#)[X]		WUE (wt)[Y]	
Interactions	2001/02	2002/03	2001/02	2002/03	2001/02	2002/03	2001/02	2002/03	2001/02	2002/03	2001/02	2002/03
Irrigation x Weeding	ns	**	**	ns	**	ns	**	ns	**	**	**	**
Irrigation x Herbicides	**	**	ns	**	*	**	*	**	**	**	**	**
Weeding x Herbicides	**	**	**	*	ns	**	ns	**	**	**	**	**
Irrigation x Weeding x Herbicides	**	**	ns	*	**	**	**	**	**	**	**	**

*, **, ns *Significant, highly significant and not significant at the 0.05 and 0.01 levels of significance, according to the Least Significance Difference Test.*

X & Y *Water use efficiencies, based on either number or weight, were estimated as number of cut flower produced or unit fresh weight/ sub-sub-plot/ each m^{-3} of water consumed.*

Table (4): Second and third order mutual interactive effects of irrigation frequencies, hand weeding, and herbicides on economic feasibility and profitability potential & indices, in field grown tuberoses (*Polianthes tuberosa, L.* cv. "Double"), during the 2001/02 and 2002/03 growing seasons, at Hada AL-Sham's Agricultural Experiment Station (Makkah AL-Mokarama Area, KSA).

Economic feasibility parameters (SR)	Total input (Costs)		Output (gross returns) [X]		Net profit		Output/input ratio		Input/output ratio		Profit/input ratio	
Interactions	2001/02	2002/03	2001/02	2002/03	2001/02	2002/03	2001/02	2002/03	2001/02	2002/03	2001/02	2002/03
Irrigation x Weeding	ns	ns	ns	**	ns	**	*	**	**	**	*	**
Irrigation x Herbicides	ns	ns	**	**	**	**	**	**	**	**	**	**
Weeding x Herbicides	ns	ns	**	**	**	**	**	**	**	ns	**	**
Irrigation x Weeding x Herbicides	ns	ns	**	**	**	**	**	**	**	**	**	**

*, **, ns *Significant, highly significant and not significant at the 0.05 and 0.01 levels of significance, according to the Least Significance Difference Test.*

X *Output (gross returns) include tuberose cut flower yield (flowering stalks), as main products and the bulbous clumps, as secondary products.*

Table (5): Pearson correlation coefficients of tuberose cut flower yield and tuberose economic feasibility indices as influenced by irrigation frequencies, manual hand weeding and herbicides, in field grown tuberoses (*Polianthes tuberosa, L.* cv. "Double".), during the 2001/02 and 2002/03 growing seasons, at Hada AL-Sham's Agricultural Experiment Station (Makkah AL-Mokaramah Area, KSA).

Parameters [@]	Cut flower yield (#)	WUE (#/ 3 m^2/m^3)	Clump diam. (cm)	Total input (cost) (SR)	Output (gross return) (SR)	Net profit (SR)	Output/ input ratio	Input/ output ratio	Net profit/input ratio
Cut flower yield (#)	——	0.51 ** 0.48 **	0.72 ** 0.77 **	0.68 ** 0.65 **	0.97 ** 0.98 **	0.98 ** 0.99 **	0.97 ** 0.98 **	- 0.80 ** - 0.81 **	0.97 ** 0.98 **
WUE (#/ 3 m^2/m^3)		——	0.19 ** 0.23 **	- 0.18 ** - 0.25 **	0.35 ** 0.33 **	0.41 ** 0.39 **	0.52 ** 0.51 **	- 0.46 ** - 0.45 **	0.52 ** 0.51 **
Clump diam. (cm)			——	0.68** 0.67**	0.74 ** 0.80 **	0.73 ** 0.79 **	0.68 ** 0.76 **	- 0.60 ** - 0.69 **	0.68 ** 0.76 **
Total input (costs) (SR)				——	0.80 ** 0.77 **	0.74 ** 0.71 **	0.65 ** 0.61 **	- 0.61 ** - 0.58 **	0.65 ** 0.71 **
Output (gross return) (SR)					——	0.99 ** 1.00 **	0.97 ** 0.97 **	- 0.84 ** - 0.84 **	0.97 ** 0.98 **
Net profit (SR)						——	0.99 ** 0.98 **	- 0.84 ** - 0.84 **	0.99 ** 0.98 **
Output/input Ratio							——	- 0.88 ** - 0.89 **	1.00 ** 1.00 **
Input/output ratio								——	- 0.88 ** 1.00 **
Net profit/input ratio									——

*ns, *, ** Indicate non significant, significant and highly significant at the 0.05 and 0.01 Levels of Significance.*
[@] The upper coefficients denote 2001/2002, and the lower ones indicate the 2002/2003 growing seasons, respectively.

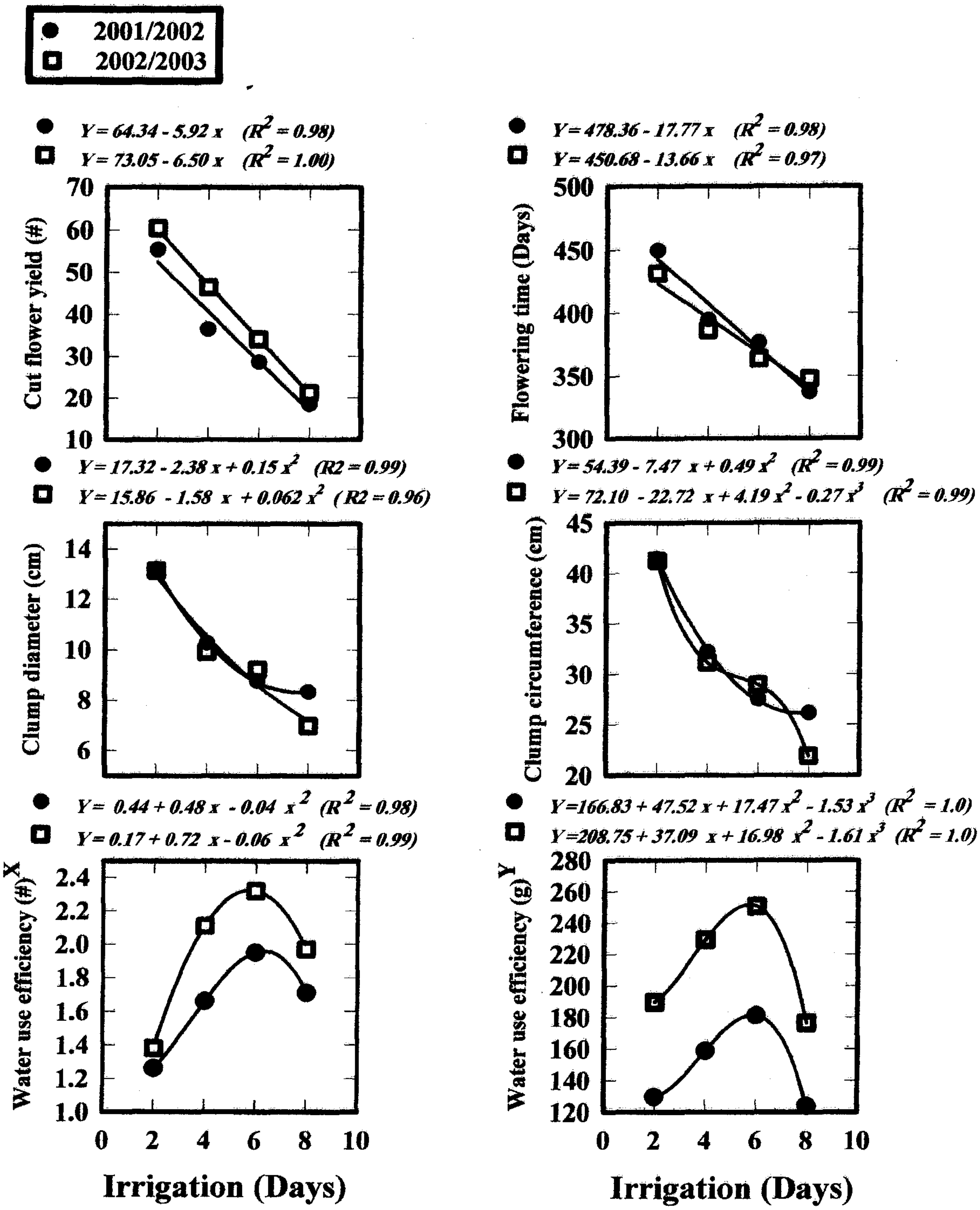

Fig. (1): First (linear), second (quadratic) and third (cubic) orders orthogonal polynomial regression analyses response curves of tuberose cut flower yield, flowering, clump characteristics and water use efficiencies, as function of irrigation frequencies; predicted (solid lines) & observed (symboles).

X & Y Water use efficiencies were estimated based on either number or fresh weight of cut flower produced / sub-sub-plot / cubic meter of water consumed.

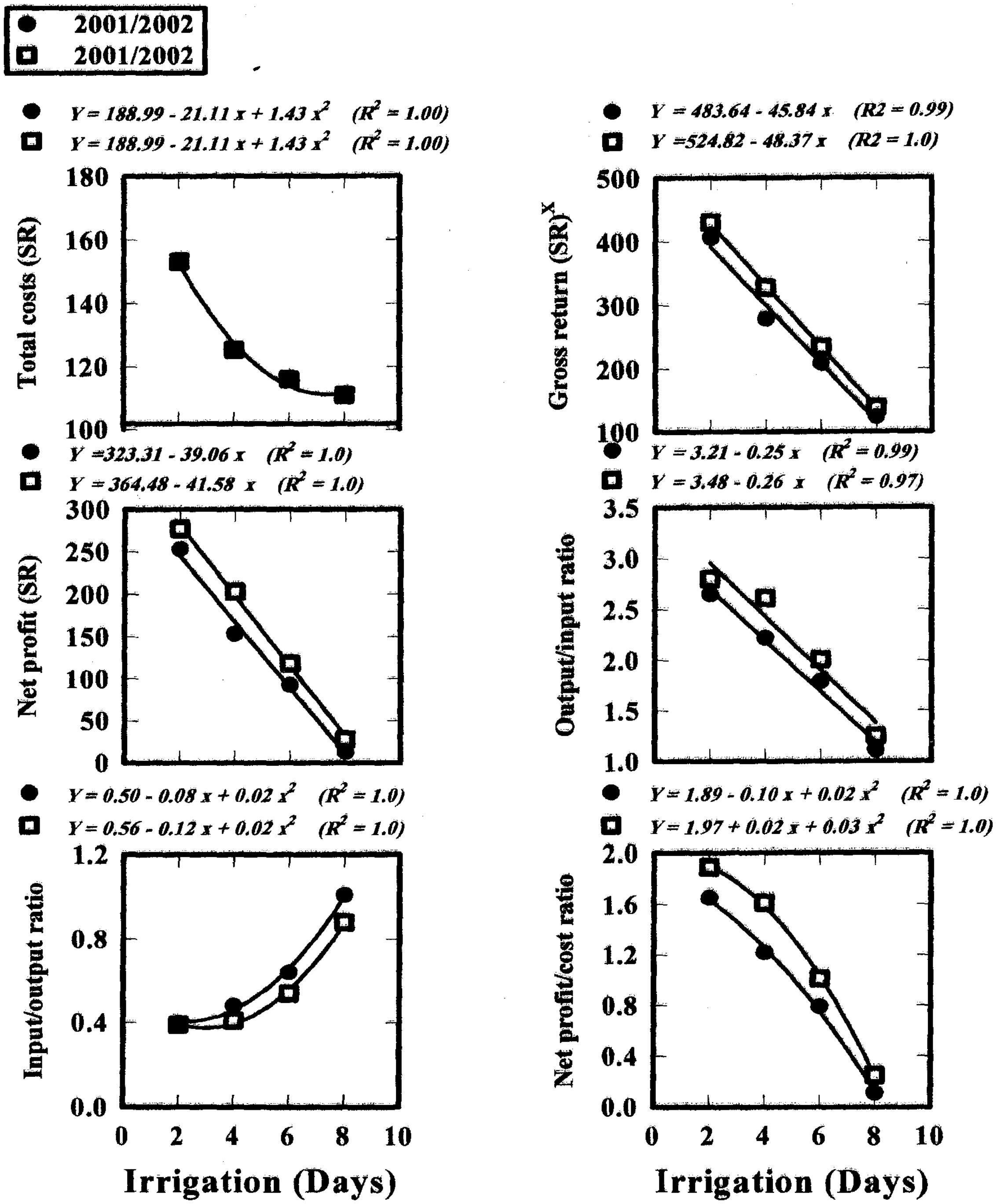

Fig. (2): First (linear) and second (quadratic) orders orthogonal polynomial regression analysese response curves, with best fitting, of tuberose production total costs (input), gross returns (output), net profit, output/input, input/output and net profit/cost (input) ratio, per sub-sub-plot (3 m^{-2}), as functions of irrigation frequencies; predicted (solid lines) & observed (symboles).

^{X} *Gross returns (output) include tuberose cut flower yield (flowering stalks), as main products, and the bulbous clumps as the secondary products.*

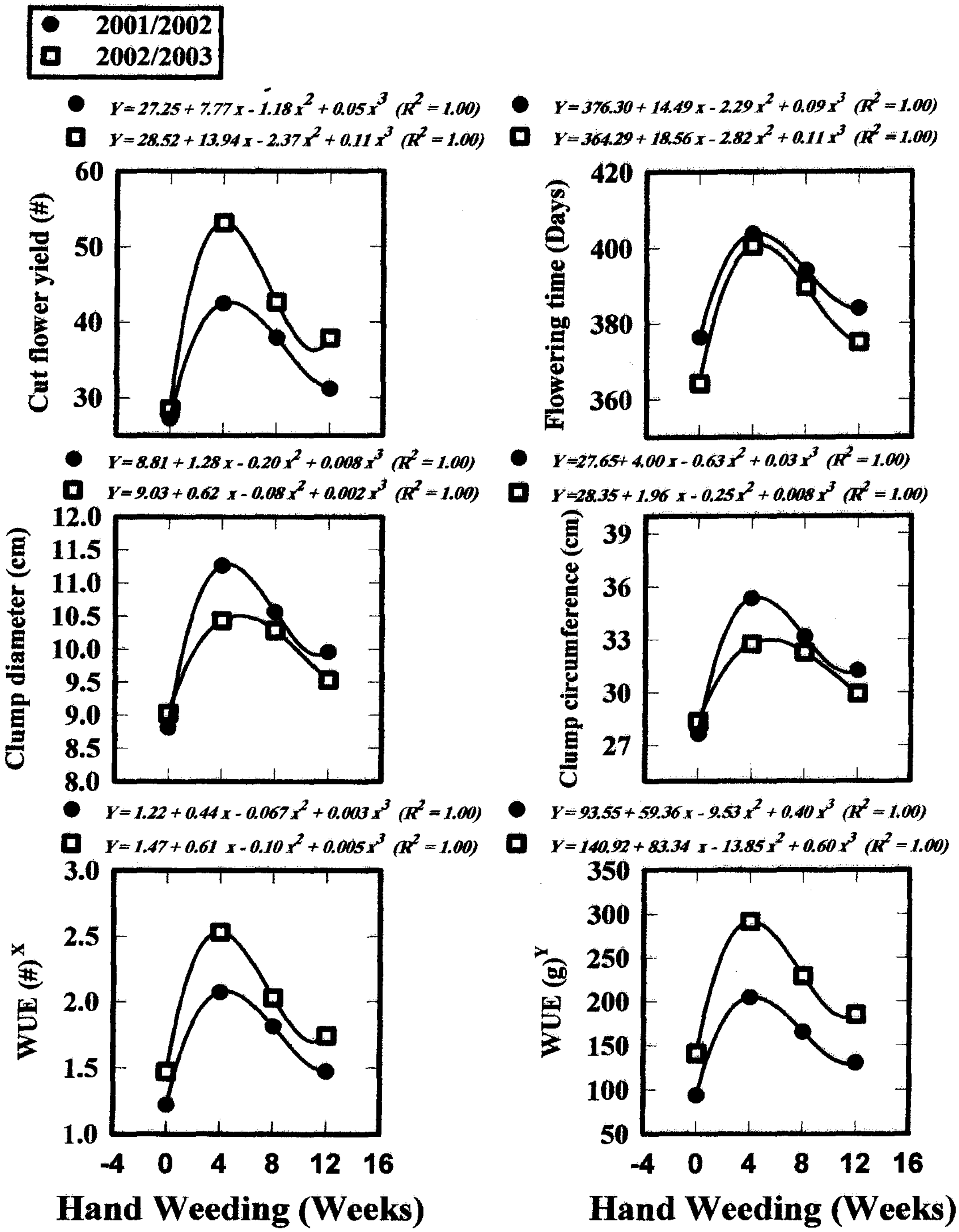

Fig. (3): Third order orthogonal polynomial regression analyses response curves of tuberose cut flower yield, flowering, clump characteristics and water use effeciencies, as functions of manual hand weeding; predicted (solid lines) & observed (symboles).

X & Y Water use efficiencies were estimated based on either number or fresh weight of cut flower produced / sub-sub-plot / cubic meter of water consumed.

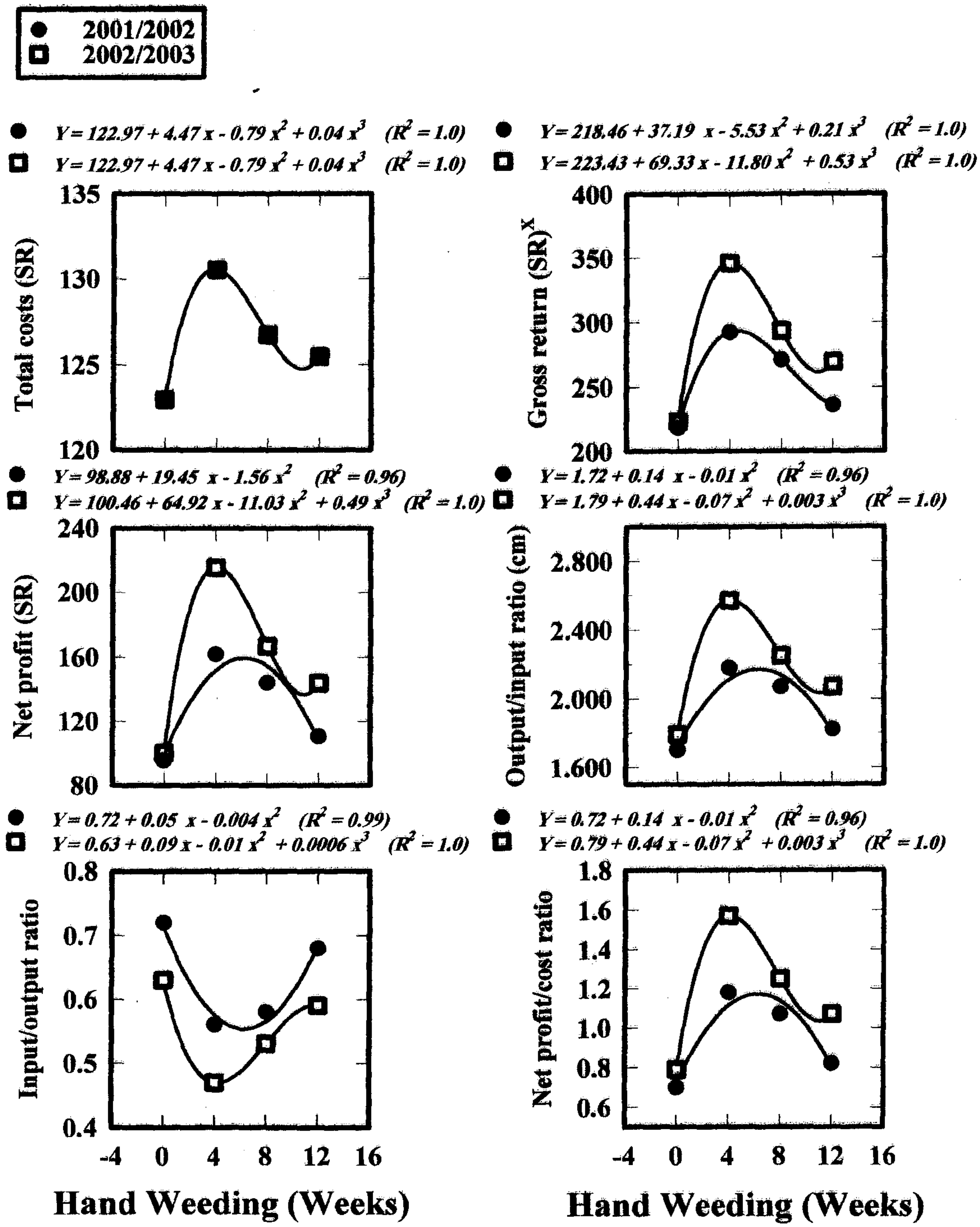

Fig. (4): Second (quadratic) and third (cubic) orders orthogonal polynomial regression analyses response curves, with best fitting, of tuberose production total costs (input), gross returns (output), net profit, output/ input,input/output and net profit/cost (input) ratio, as function to manual hand weeding; predicted (solid Lines) and observed (symboles).

[x] *Gross returns (output) include tuberose cut flower yield (flowering stalks), as Main products and the bulbous clumps as the secondary products.*

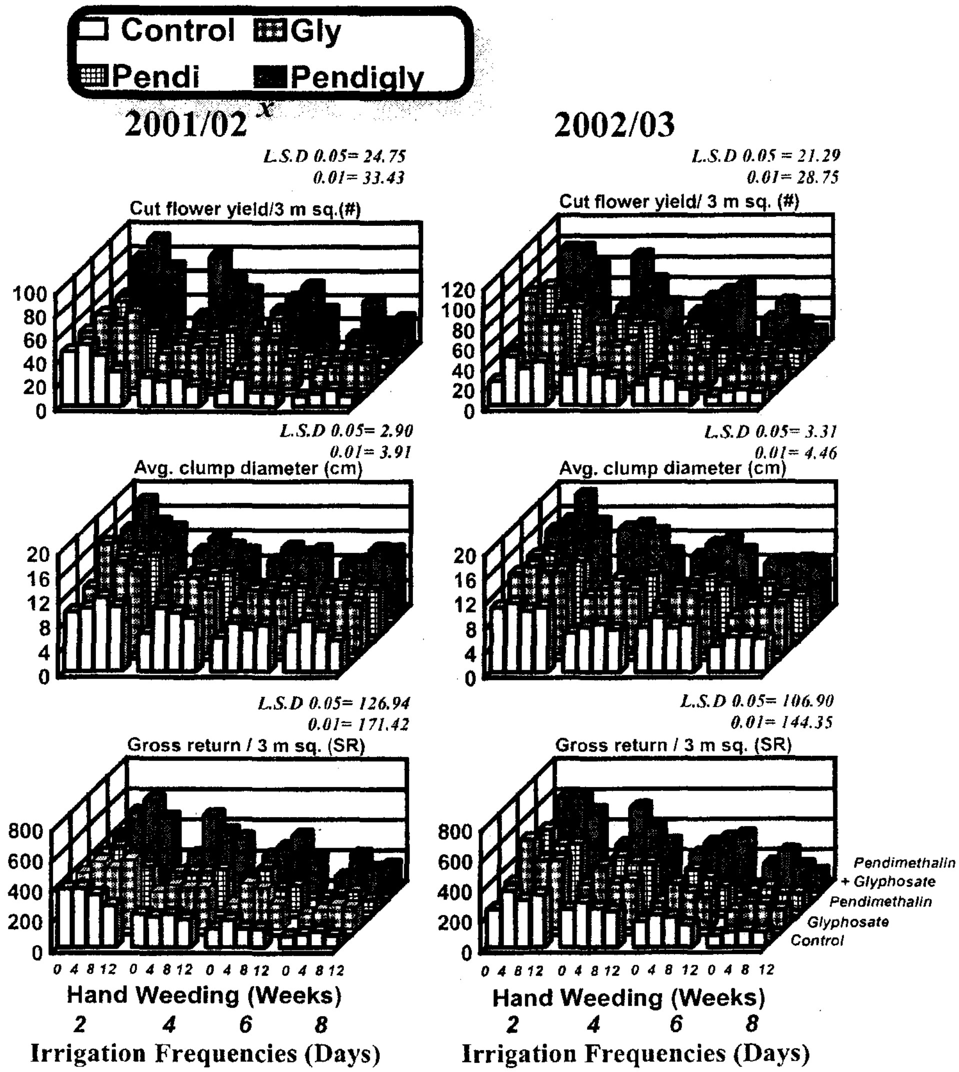

Fig. (5): Tuberose cut flower yield, average clump diameter and gross return, as influenced by the mutual interactive effects of irrigation frequencies, manual hand weeding and herbicides, during the 2001/02 and 2002/03 growing seasons, at Hada AL-Sham's Agricultural Experiment Station (Makkah AL-Mokaramah Area, KSA).

x *Abbreviation in the series denotes; Gly = Glyphosate, Pendi = Pendimethalin and Pendigly = Pendimethalin + Glyphosate.*

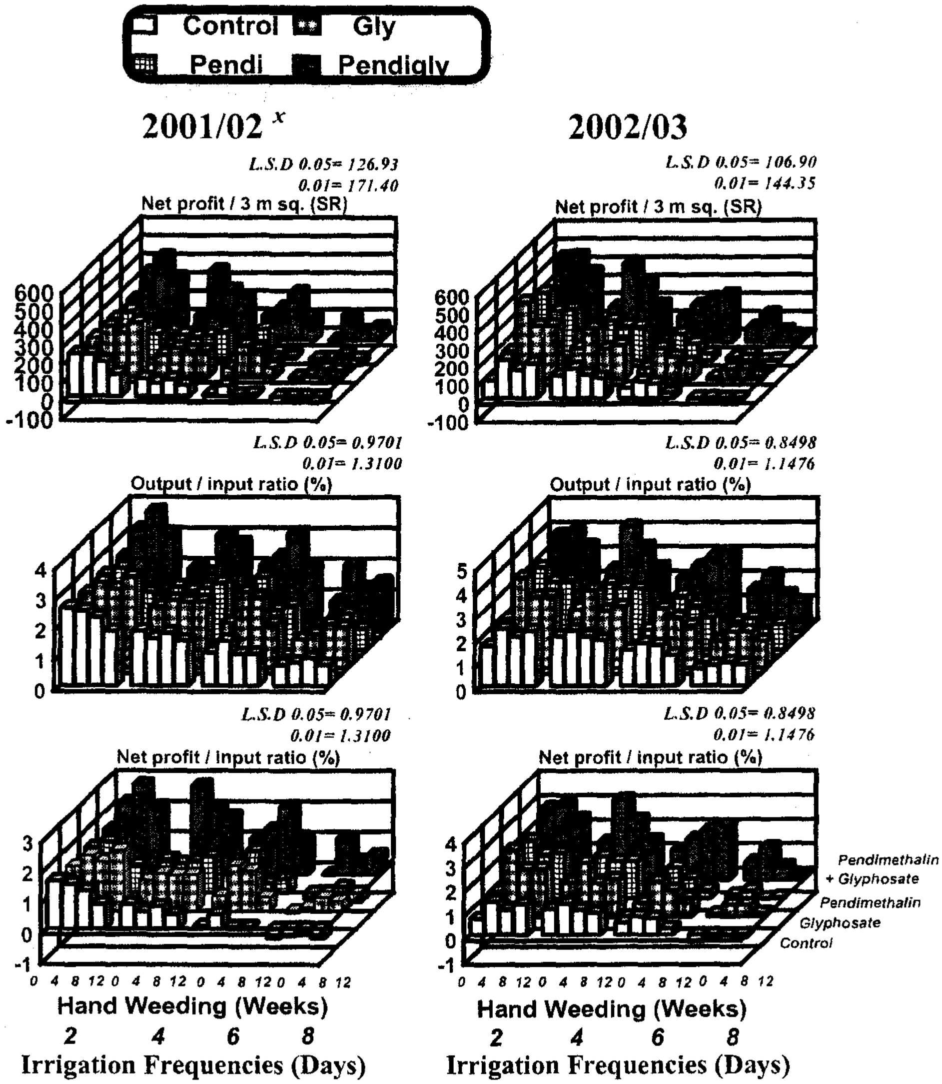

Fig. (6): Net profit (SR) / sub-sub-plot (3 m^2), output / input ratio and net profit / input ratio as influenced by the mutual interactive effects of irrigation frequencies, manual hand weeding and herbicides, during the 2001/02 and 2002/03 growing seasons, at Hada AL-Sham's Agricultural Experiment Station (Makkah AL-Mokaramah Area, KSA).

x *Abbreviation in the series denotes; Gly = Glyphosate, Pendi = Pendimethalin and Pendigly = Pendimethalin + Glyphosate.*

limiting factor for controlling the balance of water use efficiency.

3- Although frequent irrigation and watering every two days is noticeably costly and relatively lower in water use efficiencies, when compared to irrigation every four or six days, it is however, very rewarding yielding the highest gross returns, net profits, output/input ratio, net profit/input ratio and the lowest input/output ratio.
4- Manual hand weeding is considerably costly, laborious and time consuming in comparison to immensely cheaper and strongly effective use of herbicides for controlling weeds and producing remarkable tuberose cut flower yield associated with noticeable clump diameters.
5- The use of pendimethalin plus glyphosate along with any level of hand weeding with frequent every two and/or four days, produced considerable yield of tuberose cut flowers associated with remarkably developed clumps.
6- Frequent irrigation every two or four days, weeding and combination of pre- and post-emergence herbicides was very rewarding and profitable.
7- Weed control management, in field grown tuberoses, under frequent irrigation of two and/or four days is economically feasible and potentially profitable.
8- Integrated weed management, under frequently elongated irrigation period of eight days is considered not economically feasible and/or profitable, in field grown tuberoses, in The Western Region Arid Zone.

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الملخص العربى

تأثيرات تكرارات الرى ومقاومة الحشائش في حقول التيوبروز بالمنطقة الغربية للمملكة العربية السعودية : I . محصول الشماريخ الزهرية ، نمو الجور البصلية ، الجدوى الأقتصادية وإمكانية تحقيق الربحية

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أجريت تجربة حقلية في تصميم القطع المنشقة المنشقة ، ذات نظام القطاعات كاملة العشوائية ، في أربعة مكررات ، وذلك لدراسة تأثيرات تكرارات الرى (رى كل يومين ، أربعة ، ستة أو ثمانية أيام) ، المقاومة اليدوية للحشائش (بدون مقاومة ، مقاومة يدوية كل أربعة ، ثمانية أو إثنى عشر إسبوعا) ، والمقاومة باستخدام مبيدات الحشائش { بدون مقاومة ، بنديميثالين (ما قبل ظهور الحشائش) ، جليفوسات (ما بعد الظهور) ، بنديميثالين + جليفوسات } ومدى تأثير ذلك على المحصول والسلوك الزهري ، نمو الجور البصلية ، الجدوى الإقتصادية ومدى إمكانية تحقيق الربحية، تحت ظروف المنطقة الغربية ، وذلك خلال الموسم الزراعي ٢٠٠١/٢٠٠٢ وتم تكرارها في موسم ٢٠٠٢/٢٠٠٣ ، ولقد كانت أهم النتائج كالتالي:

- أدى استخدام الرى كل يومين أو أربعة أيام إلى زيادة معنوية للمحصول الزهري وكذلك امتداد فترة الإزهار بصورة ملحوظة ، وذلك بالمقارنة باستخدام الرى كل ستة أو ثمانية أيام . كما أدت هذه المعاملة أيضا إلى زيادة ملحوظة في قطر ومحيط الجور البصلية ، في كلا الموسمين .
- كان لإستخدام الرى كل أربعة أو ستة أيام دورا كبيرا في تحسين كفاءة استخدام مياه الرى بالنسبة لأعداد الشماريخ الزهرية أو وزنها الغض .
- على الرغم من أن تكلفة الرى كل يومين أو أربعة أيام كانت عالية ، إلا أن العائد الكلي كان كبيرا جدا مما أدى إلى وجود صافي ربح جيد ، كما كانت نسبة العائد الكلي وكذلك صافي الربح إلى التكاليف الكلية مرتفعة .
- أدت المقاومة اليدوية للحشائش كل أربعة أسابيع إلى زيادة أعداد الشماريخ الزهرية الناتجة للتيوبروز زيادة ملحوظة مع امتداد واضح لفترة التزهير وكذلك زيادة لكفاءة استخدام مياه الرى ، مما أدى إلى انتاج جور بصلية تتميز بأقطار ومحيط كبير ، وذلك بالمقارنة بمعاملة الكنترول أو تلك المعاملات التي قومت بها الحشائش يدويا كل ثماني أو إثنى عشر إسبوعا .
- أدت هذه المعاملة أيضا إلى تحقيق أعلى عائد اقتصادي كلي وصافي ربح وكذلك أعلى عائد على الريال ، على الرغم من التكلفة الكلية العالية للمقاومة اليدوية .
- أدى استعمال البنديميثالين كمبيد ما قبل ظهور الحشائش مع الجليفوسات كمبيد ما بعد الظهور ، معا في معاملة واحدة ، إلى تحسين الإنتاج الزهري بدرجة عالية وإطالة فترة التزهير وتحسين نمو الجور البصلية مع زيادة ملحوظة ومؤكدة في كفاءة استخدام مياه الرى ، كما أدت هذه المعاملة أيضا إلى إعطاء أعلى مؤشرات ودلائل الجدوى الإقتصادية وتحقيق الأربحية .
- كان لدمج البنديميثالين مع الجليفوسات معا في معاملة واحدة تحت أى من مستويات المقاومة اليدوية والري المتكرر كل يومين أو أربعة أيام أثرا كبيرا في زيادة عدد الشماريخ الزهرية المنتجة وتحسين مواصفات الجور البصلية للتيوبروز .
- أدت هذه المعا ملة أيضا كتفاعل ثلاثي إلى معظمة العائد الكلي وتحقيق أعلى صافي ربح وأيضا أعلى النسب للعائد إلى التكاليف وذلك بالمقارنة بمعاملات الكنترول مع المقاومة اليدوية كل ثماني أو إثنى عشر إسبوعا والمعرضة لظروف رى شديدة الإجهاد كل ثمانية أيام.
- كان هناك ارتباط وتلازم معنوي موجب بين المحصول الزهري لشماريخ التيوبروز وكل من كفاءة استخدام مياه الرى ، قطر الجور البصلية ، التكاليف الكلية ، العائد الكلي ، صافي الربح ، نسبة العائد الكلي إلى التكاليف ، نسبة صافي الربح إلى التكاليف ، بينما كان هذا التلازم سالبا مع نسبة التكاليف الى العائد .
- بينت دراسة الجدوى الإقتصادية أن مقاومة الحشائش يدويا تعتبر مكلفة للغاية لما تتطلبه من عمالة لفترة طويلة ، علاوة على أنها عملية مجهدة جدا ، وذلك بالمقارنة باستعمال مبيدات الحشائش ، حيث أنها أكثر كفاءة وأسهل أداءا وأرخص كثيرا ، عند استخدامها في حقول التيوبروز بالمنطقة الغربية للمملكة.
- بينت الدراسة أن المقاومة المتكاملة للحشائش تحت ظروف رى جيدة كل يومين أو أربعة أيام ، في حقول التيوبروز ، ذات جدوى إقتصادية وتحقق أربحية عالية .