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Effects of Irrigation Frequency Regimes and Weed Control Management, on Field Grown Tuberoses (*Polianthes tuberosa*, L.), in the Saudi Arabian Western Region: 2. Bulb and Bulblet's Yield, Growth & Development and Grade Qualities

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IMPROVING productivity of tuberose (*Polianthes tuberosa*, L.) clump's bulb and bulblet yield and associated grade qualities, not only beneficial to tuberose growers and farmers, providing eventual ideal propagating propagules, but also useful to them by raising small bulblet cloves, for future sales and/or plantations, as prospective planting materials. A Split-Split-Plot field experiment, in Randomized Complete Block Design (RCBD), with four replicates, was conducted, to investigate the effects of different irrigation frequency 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 total bulb yield produced per clump, bulb & bulblet yield, and bulb & bulblets grade qualities during the 2001/2002 and 2002/2003 growing seasons. Irrigating tuberose plants every two days significantly increased total bulb yield, expressed as number per clump. It also increased large bulb yield, weight and size, in both seasons, to other watering frequency treatments. Appreciably, improved medium bulb performance, particularly, was shown in the second growing season. Also this treatment produced the highest yield of small bulblets or cloves, weight and size per clump, to other watering frequency treatments, in the two growing seasons.

Frequent hand weeding every four weeks strongly increased total bulb yield produced compared to other hand weeding treatments, including the unweeded control, in both seasons. Frequent hand weeding every four and/or eight weeks greatly improved large bulb yield, weight and size compared to either hand weeding every twelve weeks or the unweeded control, in both seasons. Generally, medium bulbs, representing grade II bulbs and/or bulblets, as well as weight and/or size, were generally enhanced by frequent hand weeding every four and/or eight weeks, compared to unweeded control, in both seasons. Noticeably, frequent hand weeding every four weeks

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enhanced the production of small tuberose bulblets or cloves, compared to the untreated control, in both seasons.

Pendimethalin (as a preemergence) plus glyphosate (as postemergence herbicide) profoundly increased total bulb yield, large bulb yield and quality characteristics, such as weight and size in both seasons, compared to either each herbicide applied alone, separately, or the untreated control. It also improved medium bulb yield, weight and size. However, small bulblet cloves (grade III), produced per clump, either as yield numbers or as weight and size were also enhanced considerably, due to the preemergence pendimethalin plus the postemergence glyphosate applications, compared to other herbicidal treatments or the untreated control.

Tuberose clump produced the fewest yield of either large or medium bulb and/or bulblets (grade I & II), compared to the highest yield of small bulblet cloves. They were comparatively more or less equivalent in weight and/or size.

Glyphosate and/or pendimethalin plus glyphosate, at any level of hand weeding frequently irrigated every two and/or four days mostly recorded the highest yield, when relatively compared to other treatments, particularly untreated control.

Total bulb yield produced per clump, including large (grade I), medium (grade II) and small bulblet cloves (grade III) was positively correlated with large bulb yield, weight and size; medium bulb yield, weight and size; and small bulblet cloves weight and size. Conversely, it was negatively correlated with small bulblet cloves yield as numbers.

Keywords: Tuberose, *Polianthes tuberosa*, L., Irrigation frequency, Water regimes, Manual hand weeding, Herbicides, Pendimethalin, Glyphosate, Bulb yield, Bulblet cloves, Bulblet grade quality.

Tuberose plants (*Polianthes tuberosa,* L.), *Agavaceae*, are commonly and commercially propagated vegetatively, by subterranean part(s), well scientifically known as propagules (Watako, 2006). These propagules are horticulturally known by floricultural researchers and investigators as bulbs (El_Naggar and Byari, 1999; and Raja & Palanisamy, 2000); corms (Asif *et al.*, 2001); and sometimes as tubers (Kumar and Dixit, 2007); or rhizomes (Sangavai and Chellapandi, 2008). However, these bulbs produce bulblets of different size surrounding the main mother bulbs, forming what is called tuberose clumps, by the end of the growing season. Clumps are very important, for tuberose production. They are considered as the main source for the new propagating materials for eventual and/or prospective plantations. However, tuberose clumps include bulbs of different size. They are commonly categorized as large, medium and small bulblets and/or cloves. However, numbers of bulb and/or bulblets produced per clump are always in great association with clump

developmental vigor, according to Raja and Palanisamy, 2000. Nevertheless, large as well as medium bulbs are normally grown and bloomed at the same growing season. Meanwhile, small bulblets or cloves are usually subjected to raising and breeding program(s), and remain at least one growing season, to grow and reach reasonable maximum size. Often, clumps are sold in nurseries, garden centers and frequently sold directly by tuberose growers. However, tuberose clumps are exported in a limited scale to the neighboring Arabian countries. It has great potentiality to be exported overseas (EL-Naggar and Byari, 1999).

In Saudi Arabia, more than 70 % of the total area is considered as rangelands covered with sand in one form or another, with the exception of vallies, such as Fatma Valley, Hada AL-Sham's Valley, etc. The poor sandy soil along with high ambient temperature, exceeding 40 °C during summer months as well as drought and lack of good quality water are the major constrains for any agricultural development. Notwithstanding, diversifying horticultural crops, in the Western Region strongly motivated the introduction of new floricultural crop(s) to the area. Tuberose clumps were imported from Egypt. The aim was to establish and to acclimatize tuberose outdoor under the arid zone conditions of the Western Region. Successfully, establishment as well as acclimatization was accomplished in earlier pioneer trials (EL-Naggar and Byari, 1999), resulting in potentially new floricultural crop in the region. However, extensive horticultural agro-technique program(s) were essentially required for tuberose improvement, under such severe and harsh prevailing conditions.

It is well documented in plant-water relation's literature always there was a critical balance between water requirement and water consumption of any grown crop(s). Hence, conserving water is an important aspect for agricultural expansion, particularly, in arid and semi arid regions, where water deficit and high temperature are the main limiting factors for plant growth and productivity, according to Taiz and Zeiger (2002). However, water deficit, however, often causes reduction in plant growth by inhibiting leaf and stem elongation (Younis *et al.*, 2000) and by reducing nutrient uptake by plants (Taiz and Zeiger, 2002). In addition, water deficit also could negatively affects the process of flowering, in many plant species, by reducing the fertility of newly formed flowers, according to Slawinska and Obendorf (2001). Nonetheless, many scientists working on different ornamental bulbs revealed that increasing irrigation frequencies or reducing watering intervals, not only increased underground subterranean organ's yield, but also improved the quality according to Papaneck (1992) on Tulip; EL-Naggar and Nassar (1994) on Narcissus; Wright and Burge (2000) on Calla; Nabih *et al.* (1992); and Halepyati *et al.*, (2002) on Tuberose; Zehan *et al.* (2006), on Crocus; Kulkarni *et al.* (2005) and El_Hanafy *et al.* (2006) on Ornithogalum; and Wiwatpinyo *et al.* (2008) on Turmeric. Moreover, the favorable impacts of increasing irrigation frequencies or shortening watering intervals were also documented, in the literature, on the underground organs of Onions (Neeraja *et al.*, 1999; and Lal *et al.*, 2002); Potatoes (Samudar and Thind, 2005); and Sweet Potato (Chowdhury *et al.*, 2007).

Amongst constrains menacing high productivity of bulbs in field-grown tuberoses was weed growth and swarm, particularly under furrow irrigation system (Sutton *et al.*, 2007). Weed competition and interference with such a crop result in great reduction and decline in crop yield. Reduction in crop yields due to weeds, result from their diverse ways of interfering with crop growth and crop culture. Weeds compete with crops for one or more plant growth factor(s), such as mineral nutrients, water, solar energy and space and they significantly burden crop cultivation operations (Zimdahl, 2004). Therefore, integrated weed management, in field-grown tuberoses was substantially imperative, and Strategic agrochemical approaches were obligatory, to overcome weed competition problems.

Traditionally, weeds have long been and still controlled by conventional mechanical means, such as cultivation and hand hoeing or even manual hand weeding, particularly in developing countries, and it have been directed in recent years toward organic farming cropping system (Riemens *et al.*, 2007). However, mechanical weeding was proven not only very efficient in controlling weeds, in different ornamental bulb plantations, but also dreadfully beneficial, in enhancing growth and development of underground subterranean-storing-organs, according to Mohanty *et al.* (2002); and Panwar *et al.* (2005) on Tuberoses; Widaryanto *et al.* (1997); and DongChun *et al.* (2000) on Gladioli; Bullitta *et al.* (1996) on Crocus; and Santosa *et al.*, (2006) on Elephant Foot Yam. Nevertheless, mechanical ways, for controlling weeds, on the other hand, are arduous, laborious, backbreaking and exhausting, which subsequently lead to immense increase in production costs (Ramirez *et al.*, 2007). Besides, it may adversely affect subterranean crop yield significantly, due to root system disturbance, during weed uprooting operation, according to Levett (1992). Nonetheless, the use of chemical herbicides (preemergence and/or postemergence) for weeding solely and/or as an ancillary approach(s), to mechanical means, could reduce labor by 61.5 to 87.7 %, which subsequently decrease weeding costs by 40.2 to 70.9 %, when compared to manual weeding. Also it could reduce water & soil losses and surface water evaporation, creating good ecological environment for growth according to JianRong (2004). Herbicidal chemicals, such as pendimethalin as preemergence herbicide, or glyphosate as postemergence one were, however, reported to significantly improve bulb and bulblets yield in numerous ornamental bulbs including Tuberose (Pal & Das, 1990 and Panwar *et al.*, 2005); Gladiolus (Bing *et al.*, 1988; Mynett & Jagusz, 1990 and Arora *et al.*, 2002); Elephant Foot Yams (Bhaumik *et al.*, 1988); and Iris (Ivanova, 1999).

This study was undertaken to evaluate the performance of subterranean bulb yield, bulb and bulblet growth and development as well as bulb grade qualities, as influenced by irrigation frequency regimes, manual hand weeding and chemical herbicidal treatments, under the Saudi Arabian Western Region Arid Zone conditions.

Material and Methods

The concurrent investigation was conducted at Hada AL-Sham's Agricultural Experimental Station (HAAES), for Ornamental Plants Researches and Indoor Plant Propagation (OPRIPP), 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, 2002/2003.

Plant materials

Excellent quality tuberose mother clumps were imported from Egypt. 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, after bulb and bulblets separation. However, the remainders of bulbs and/or bulblets were subjected to raising and breeding programs.

A Split-Split-Plot field experiment, in Randomized Complete Block Design (RCBD), with four replicates, by 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. However, detailed materials, methods and experimental procedures, were documented by El-Naggar and Byari (2007 a & b).

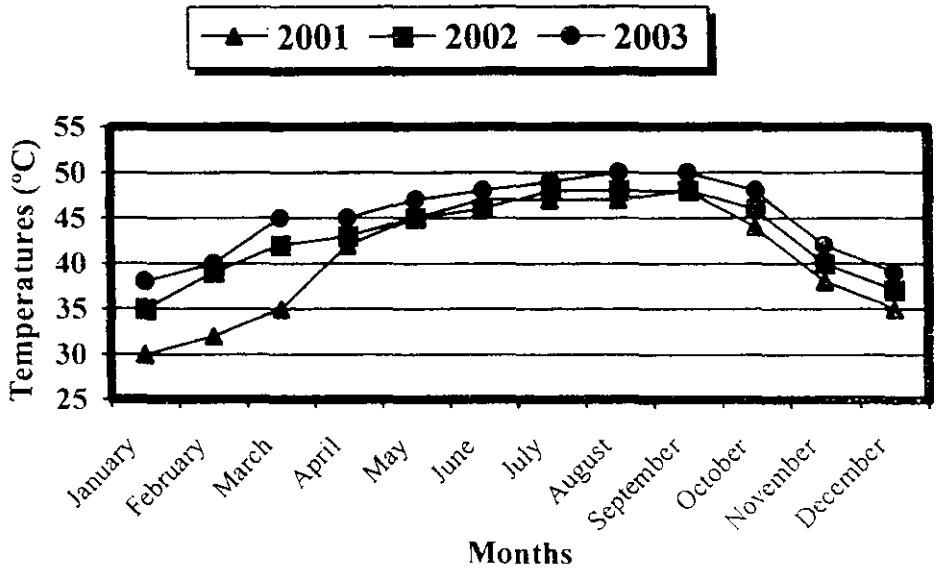

Fig. A: Maximum monthly temperatures (°c), at Hada Al-Sham's Agriculture Experiment Station (Makkah Al-Mokaramah Area, KSA), over three consecutive gregorian years; 2001, 2002 and 2003.

Tuberose bulbs ranging size (3.5 – 4.5 cm) in diameter, and 38-55 g average weight, 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 material(s), in the area, such as roots, bulbs, tubers...etc.

Experimental procedures and treatments applications

Irrigation frequencies and watering intervals

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 water pump of 4.5 horsepower was also installed to deliver water in main, sub-main, and sub-sub-main pipes and tubes, in six-Bar active pressure, to the experimental plots, from these tanks. Irrigation treatments; irrigation 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), occupied an area of 48 m^2, required 3.00 m^3 of irrigation water, 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, during the whole coarse of the investigation, were 703.00, 352.50, 235.08, and 172.87 cubic meters/whole unit on the average, which were corresponding to irrigation every two, four, six, and eight days, respectively. However, irrigational treatments and watering intervals scheduling were started after two months from the initial bulb planting. However, tuberose bulbs were, 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

Several farm workers performed manual hand weeding and hoeing 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 (monthly interval), sub-plots weeded every eight weeks (bimonthly), and sub-plots weeded every twelve weeks.

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 also 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 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 collection

Bulb(s) and bulblet(s) growth parameters measurements

Measurements and data recording on tuberose underground materials were undertaken at the end of investigations, on October 23rd, and 25th in both seasons, respectively. Tuberose clumps were dug out, classified according to the corresponding treatment plots, packed, and transferred, through Tractors, to the greenhouses working areas. Then clumps were gently washed from any adhering soil, several times, and subjected to measurements and data recording. Measurements included average total bulb yield per clump (#). Then bulbs were separated from rhizomatous clumps, classified and categorized into three main groups, according to size; large bulbs (greater than 3.5 cm diameter); medium (2.0 to 3.5 cm diameter); and small cloves (less than 2.00 cm diameter), as an average per plant or per clump. However, each category was counted as number and weight (g). Average size (cc) was also estimated, according to Archimedes displacement law. Specific gravity (g/cc) was also calculated.

Statistical analyses

Statistical analyses were performed using the General linear Model (*GLM*) procedure, along with the regular analysis of variance, SAS computer package (version 8.0), 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). However, Correlation analyses were also performed among different parameters.

Results and Discussions

Impacts of irrigation frequency regimes

Irrigating ornamental bulbs is indispensable horticultural practices, especially under the Arid Zone harsh environmental conditions, according to Taiz and Zeiger (2002), where water deficit induced harmfully deteriorating effects, restricting plant growth and development.

Irrigation frequency regimes profoundly affected tuberose bulb and bulblets produced per clump, in both seasons (Table 1). Irrigating tuberose plants every two days considerably increased total bulb yield (expressed as number per clump). It also increased large bulb weight and size, in both seasons, compared to other watering frequency treatments. However, plant frequently irrigated every eight days showed comparatively unfavorable performances. Table (2) exhibits behavioral performances of medium bulb, weight and size per clump, as influenced by irrigation frequency regimes, in both seasons. Frequent irrigation every two days significantly improved medium bulb performances, particularly, in the second growing season, compared to other watering treatments. However, a noticeable trend was observed in the first growing season, although no significant differences were detected. Tuberose small-bulblet-clove yield, weight and size were strongly influenced by irrigation-frequency-regime treatments (Table 3). Frequent irrigation and watering every two days produced the highest yield of small bulblets or cloves, weight and size per clump, compared to other watering frequency treatments, in both seasons. Figure (1) exhibits performances of tuberose bulb and bulblet's (large, medium and small) yield, weight and size, as well as total bulb yield produced per clump, in both seasons. Generally, total bulb yield was greatly enhanced by frequent irrigation every two days, compared to other watering frequency treatments. However, it constitutes large, medium and small bulb and or bulblets produced per clump. It is worth notable that frequent irrigation every two days immensely produced the heaviest total bulb yield per clump (23.15 & 23.39), compared to other irrigating water treatments, in both seasons, respectively. These produced yields included large (2.83 & 3.24), medium (3.27 & 4.02) and small (17.05 & 16.12) cloves, in both seasons, respectively. However, although large as well as medium bulbs were relatively fewer than those of small cloves, constituting only 16.6 & 20.10 % (large) and 19.18 & 24.93 % (medium) of small clove yield as numbers, they were comparatively heavier in weight; 73.31 & 95.27 % (large); 68.94 & 83.41 %

(medium) and bigger in size; 63.14 & 95.99 (large); 56.79 & 85.60 % (medium), in both seasons, respectively, compared to small-bulblet-clove weight and size. The immensely noticeable performances of tuberose bulb and bulblet yield per clump perhaps might be attributed mainly to condensed frequent irrigation and watering providing high available soil moisture, rich in minerals and nutrients. It might be had the benefit of initiated bulb and bulblets early on the rhizomatous clump, allowing them to grow and develop well, forming large and/or medium bulbs. Moreover, comprehensive watering and high available soil moisture contents were also beneficial encouraging higher number of small bulblet cloves to initiate, later in the season rather than growing well and competing with large and/or medium bulbs, for spaces and/or photosynthates, on the subterranean rhizomatous clump. Nevertheless, Papaneck (1992) on tulip; EL-Naggar and Nassar (1994) on narcissus; Wright and Burge (2000) on calla; Nabih *et al.*, (1992) and Halepyati *et al.* (2002) on tuberose; Zehan *et al.* (2006) on crocus; Kulkarni *et al.* (2005) and EL-Hanafy *et al.* (2006) on ornithogalum; and Wiwatpinyo *et al.* (2008) on turmeric, highly emphasized the significance of increasing irrigation frequencies and/or levels and increasing volumetric irrigation water or reducing watering intervals, in increasing underground subterranean storing organ's yield and enhancing the qualities of numerous ornamental bulbs, as well as non-ornamental bulbs such as onion, potatoes and sweet potatoes according to Neeraja *et al.* (1999), Lal *et al.* (2002) Samudar & Thind (2005) and Chowdhury *et al.* (2007).

Impacts of manual hand weeding

Manual hand weeding immensely affected tuberose total bulb yield produced per clump, in both seasons (Table 1). It also influenced performances of large bulbs, produced per clump considerably. Frequent hand weeding every four weeks strongly increased total bulb yield produced in compared to other hand weeding treatments, including the unweeded control, in both seasons. However, hand weeding every eight or twelve weeks were considerably superior when compared to those of the unweeded control. Large bulb yield, or grade I bulbs, produced per clump, as a main category of the total bulb yield produced per clump, as well as weight and size, were also influenced by the different hand weeding treatments, in both seasons. Frequent hand weeding every four and/or eight weeks greatly improved large bulb yield, weight and size considerably, compared to either hand weeding every twelve weeks or the unweeded control, in both seasons. Medium bulbs, representing grade II bulbs and/or bulblets, produced per clump, as well as weight and/or size, were generally enhanced by frequent hand weeding every four and/or eight weeks, compared to unweeded control, in both seasons (Table 2). Table 3 exhibits behavioral performances of small bulblets or cloves, as grade III, produced per clump, as influenced by manual hand weeding treatments. Frequent hand weeding every four weeks noticeably enhanced the production of small tuberose bulblets or cloves, compared to the untreated control, in both seasons. It also improved weight and size. Pictorial histograms presented on Fig. 2 clearly demonstrate performances of tuberose bulb and bulblets produced per clump, in both seasons. These bulb and bulblets included large, medium and small cloves. Notably, frequent hand

weeding every four and/or eight weeks produced the highest total bulb yield, in both seasons. However, even though hand weeding every four and/or eight weeks produced few large and medium bulbs (2.45, 3.76; 2.27, 3.27 & 2.79, 3.36; 2.514, 3.67) in the two growing seasons, respectively, compared to small-clove-yields (13.48, 12.26 & 14.97, 12.48), they were comparatively and relatively almost equal to small cloves in weight and/or size. Nevertheless, the noticeable production of relatively few yield, as number, of grade I (large) and grade II (medium) bulb and/or bulblets, compared to small bulblet cloves produced, yet comparatively having comparable weight and/or size, might be attributed to initial nutritional status provided to early developed bulb and/or bulblets, induced by the strong impacts of hand weeding, eliminating weed/tuberose competitions for water, nutrients, spaces and solar energy. However, bulblets developed on tuberose rhizomatous clumps later on the growing season. It might have been tended to increase in numbers rather than increasing in size and/or weight. Nonetheless, researches conducted by Mohanty *et al.,* (2002); and Panwar *et al.,* (2005) on tuberose; Widaryanto *et al.,* (1997); and DongChun *et al.,* (2000) on gladiolus; Bullitta *et al.,* (1996) on crocus; and Santosa *et al.,* (2006) on elephant foot yam, stressed the significance of weeding in increasing subterranean organ's yield and improving its qualities including weight and or size.

Impacts of herbicidal treatments

Tuberose total bulb yield, including large or grade I bulb, performances as influenced by the different herbicidal treatments are presented in Table (1). Pendimethalin (as a preemergence) plus glyphosate (as postemergence herbicide) profoundly increased total bulb yield, in both seasons, compared to either each herbicide applied alone or the control. However, either glyphosate or pendimethalin also significantly increased total bulb yield produced per clump compared versus the control, in the two growing seasons.

Large bulb yield (grade I bulbs) as we;; as weight and size, and components of total bulb yield produced per tuberose clump, were immensely enhanced by the different herbicidal treatments. Obviously, pendimethalin plus glyphosate treated sub-sub-plots, not only produced the highest large bulb but also yielded the best quality characteristics, such as weight and size, in both seasons, compared to glyphosate alone or pendimethalin alone or even the control. However, glyphosate and/or pendimethalin herbicides also improved large bulb and markedly hastened quality characteristics traits, including weight and size, to untreated control, in both seasons. However, orthogonal contrast, however, breaking down the three degrees of freedom, into single ones, with all possible contrasts, revealed highly significant effects. Analyses of orthogonal contrast components conferred that there were strong synergistic impacts for glyphosate and pendimethalin, when they coexisted together, in one single treatment, as functioning preemergence and postemergence herbicides.

TABLE 1. Impacts of irrigation frequencies, hand weedings and herbicides on tuberose total bulb yield, large bulb yield, weight, size and specific gravity, 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).

Growth parameters (avg.)/ clump	Total bulb yield (#)		Large bulb yield (#)		Large bulb weight (g)		Large bulb size (cc)		Large bulb SG (g/cc)	
Treatments	2001/02	2002/03	2001/02	2002/03	2001/02	2002/03	2001/02	2002/03	2001/02	2002/03
• Irrigation frequencies (Days)[1]										
Two	23.15 a	23.39 a	2.83 a	3.24 a	101.76 a	159.28 a	93.17 a	148.24 a	1.09 a	1.07 a
Four	16.63 b	17.41 b	2.36 b	2.27 b	067.70 b	079.36 b	57.82 b	063.99 b	1.18 a	1.24 a
Six	15.40 b	16.60 b	1.80 c	2.09 bc	055.60 b	051.73 b	45.11 b	048.70 b	1.23 a	1.06 a
Eight	14.96 b	14.59 b	1.59 c	1.82 c	037.53 c	053.48 b	30.56 c	038.04 b	1.23 a	1.42 a
F-Test	**	**	**	**	**	**	**	**	ns	ns
LSD 0.05	1.88	3.64	0.22	0.41	15.89	31.06	14.03	30.52	—	—
0.01	2.70	5.23	0.32	0.58	22.82	44.62	20.16	43.85	—	—
Polynomial regression										
Linear	**	**	**	**	**	**	**	**	ns	ns
Quadratic	**	ns	ns	*	ns	**	*	**	ns	ns
Cubic	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
• Manual weeding (Weeks)										
Control	15.81 c	14.44 d	1.83 b	1.86 d	51.11 b	053.43 d	43.95 b	043.98 d	1.17 a	1.22 a
Four	19.69 a	21.32 a	2.45 a	2.79 a	79.20 a	129.25 a	70.73 a	112.07 a	1.12 a	1.16 a
Eight	17.79 b	18.67 b	2.27 a	2.51 b	72.54 a	093.65 b	61.96 a	081.47 b	1.17 a	1.15 a
Twelve	16.84 bc	17.57 c	2.03 b	2.25 c	59.74 b	067.54 c	50.03 b	061.46 c	1.17 a	1.11 a
F-Test	**	**	**	**	**	**	**	**	ns	ns
LSD 0.05	1.12	0.86	0.21	0.22	10.40	11.40	09.89	11.68	—	—
0.01	1.50	1.16	0.28	0.30	13.94	15.28	13.27	15.66	—	—
Polynomial regression										
Linear	**	**	*	**	*	**	**	**	ns	ns
Quadratic	**	**	**	**	**	**	**	**	ns	ns
Cubic	**	**	ns	ns	ns	**	**	**	ns	ns
• Herbicides										
Control	12.72 d	12.59 d	1.38 d	1.60 d	027.24 c	044.97 d	019.32 c	034.72 d	1.42 a	1.32 a
Pendimethalin	15.86 c	16.28 c	1.59 c	2.08 c	037.27 c	065.97 c	027.69 c	053.43 c	1.35 a	1.23 a
Glyphosate	18.56 b	19.70 b	2.49 b	2.55 b	071.53 b	101.17 b	065.61 b	090.52 b	1.10 a	1.13 a
Pendimethalin + Glyphosate	22.98 a	23.42 a	3.13 a	3.20 a	126.55 a	131.75 a	114.04 a	120.29 a	1.12 a	1.11 a
F-Test	**	**	**	**	**	**	**	**	ns	ns
LSD 0.05	1.37	1.55	0.20	0.20	11.50	12.47	11.41	12.68	—	—
0.01	1.80	2.05	0.26	0.26	15.19	16.47	15.07	16.75	—	—
Orthogonal contrast[1]										
Control vs Others	**	**	**	**	**	**	**	**	ns	ns
Pendi. vs Pendi. + Glyphosate	**	**	**	**	**	**	**	**	ns	ns
Gly. vs Pendi. + Glyphosate	**	**	**	**	**	**	**	**	ns	ns

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

[2] *Means with the same letters are not significantly different, at the 0.05 level of significance, according to the Least Significance Test.*

[3] *Abbreviations, for orthogonal contrasts, denote; Pendi = Pendimethalin, Gly = Glyphosate and Pendi + Gly = Pendimethalin + Glyphosate.*

TABLE 2. Impacts of irrigation frequencies, hand weedings and herbicides on tuberose medium bulb yield, weight, size and specific gravity, 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).

Growth parameters (avg.)/clump	Medium bulb yield (#)		Medium bulb weight (g)		Medium bulb size (cc)		Medium bulb SG (g/cc)	
Treatments	2001/02	2002/03	2001/02	2002/03	2001/02	2002/03	2001/02	2002/03
• Irrigation frequencies (Days)[1]								
Two	3.27 a	4.02 a	95.79 a	139.44 a	83.80 a	131.82 a	01.14 a	1.07 a
Four	3.22 a	3.54 b	94.57 a	112.27 b	80.42 a	094.60 b	01.18 a	1.21 a
Six	3.01 a	3.07 c	88.64 a	087.72 c	77.95 a	076.85 c	01.14 a	1.14 a
Eight	3.01 a	2.74 c	84.37 a	073.80 c	78.00 a	067.18 c	01.10 a	1.11 a
F-Test	ns	**	ns	**	ns	**	ns	ns
LSD 0.05	———	0.41	———	14.64	———	12.25	———	———
0.01	———	0.59	———	21.04	———	17.59	———	———
Polynomial regression								
Linear	*	**	ns	**	ns	**	ns	ns
Quadratic	ns	ns	ns	ns	ns	**	ns	ns
Cubic	ns	ns	ns	ns	ns	ns	ns	ns
• Manual weeding (Weeks)								
Control	2.62 c	2.89 c	074.53 b	077.56 c	62.88 c	070.34 c	1.20 a	1.12 a
Four	3.76 a	3.56 ab	108.43 a	134.45 a	99.60 a	123.10 a	1.12 a	1.10 a
Eight	3.27 b	3.67 a	106.46 a	104.07 b	81.91 b	086.72 b	1.33 a	1.22 a
Twelve	2.87 c	3.28 b	073.96 b	097.16 b	75.79 b	090.29 b	0.98 a	1.08 a
F-Test	**	**	**	**	**	**	ns	ns
LSD 0.05	0.31	0.31	18.36	12.89	11.69	14.30	———	———
0.01	0.41	0.42	24.62	17.28	15.67	19.17	———	———
Polynomial regression								
Linear	**	*	ns	**	**	**	ns	ns
Quadratic	**	**	**	**	**	**	ns	ns
Cubic	*	ns	ns	**	*	**	ns	ns
• Herbicides								
Control	2.22 d	2.21 d	063.81 c	065.69 d	051.33 d	060.61 d	1.24 a	1.10 a
Pendimethalin	2.80 c	2.87 c	072.88 c	084.77 c	067.34 c	077.76 c	1.25 a	1.07 a
Glyphosate	3.18 b	3.54 b	094.97 b	105.17 b	088.52 b	096.85 b	1.07 a	1.08 a
Pendimethalin + Glyphosate	4.31 a	4.78 a	131.72 a	157.60 a	112.99 a	135.23 a	1.19 a	1.19 a
F-Test	**	**	**	**	**	**	ns	ns
LSD 0.05	0.30	0.32	16.87	10.64	08.31	09.95	———	———
0.01	0.40	0.42	22.28	14.05	10.98	13.15	———	———
Orthogonal contrast[2]								
Control vs Others	**	**	**	**	**	**	ns	ns
Pendi. vs Pendi. + Glyphosate	**	**	**	**	**	**	ns	ns
Gly. vs Pendi. + Glyphosate	**	**	**	**	**	**	ns	ns

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

[1] Means with the same letters are not significantly different, at the 0.05 level of significance, according to the Least Significance Test.

[2] Abbreviations, for orthogonal contrasts, denote; Pendi = Pendimethalin, Gly = Glyphosate and Pendi + Gly = Pendimethalin + Glyphosate.

TABLE 3. Impacts of irrigation frequencies, hand weedings and herbicides on tuberose small bulb yield, weight, size and specific gravity, 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).

Growth parameters (avg.)/ clump	Small bulb yield (#)		Small bulb weight (g)		Small bulb size (cc)		Small bulb SG (g/cc)	
Treatments	**2001/02**	**2002/03**	**2001/02**	**2002/03**	**2001/02**	**2002/03**	**2001/02**	**2002/03**
•Irrigation frequencies (Days)[Y]								
Two	17.05 a	16.12 a	138.81 a	167.18 a	147.55 a	154.44 a	0.94 a	1.10 a
Four	11.05 b	11.59 b	095.50 b	123.37 b	103.87 b	093.56 b	0.92 a	1.32 a
Six	10.95 b	11.43 b	070.78 bc	093.77 b	054.42 c	065.04 b	1.35 a	1.44 a
Eight	10.35 b	10.04 b	050.33 c	085.72 b	045.38 c	060.63 b	1.13 a	1.40 a
F-Test	**	**	**	**	**	*	ns	ns
LSD 0.05	1.74	3.38	32.05	41.60	12.52	36.53	———	———
0.01	2.51	4.85	46.00	59.74	17.98	52.48	———	———
Polynomial regression								
Linear	**	**	**	**	**	*	ns	ns
Quadratic	**	ns	**	ns	**	**	ns	ns
Cubic	ns	ns	ns	**	**	*	ns	ns
• Manual weeding (Weeks)								
Control	11.36 b	09.69 c	068.85 b	104.83 b	080.97 ab	073.13 b	0.85 a	0.70 a
Four	13.48 a	14.97 a	101.48 a	142.56 a	101.04 a	100.39 a	1.00 a	1.44 a
Eight	12.26 ab	12.48 b	092.52 ab	113.46 b	090.88 ab	086.11 ab	1.02 a	1.33 a
Twelve	11.23 b	12.04 b	092.58 ab	109.20 b	078.32 b	071.03 b	1.18 a	1.54 a
F-Test	*	**	**	**	*	**	ns	ns
LSD 0.05	1.39	0.79	29.51	21.40	22.20	18.12	———	———
0.01	1.87	1.06	39.57	28.70	29.77	24.29	———	———
Polynomial regression								
Linear	ns	**	**	ns	ns	ns	ns	ns
Quadratic	*	**	**	**	*	**	ns	ns
Cubic	ns	**	*	*	ns	ns	ns	ns
• Herbicides								
Control	09.12 d	08.79 d	068.84 b	094.37 b	072.67 b	048.18 b	0.96 a	1.96 a
Pendimethalin	11.47 c	11.34 c	091.04 ab	113.31 ab	092.71 ab	069.34 b	0.95 a	1.63 a
Glyphosate	12.90 b	13.61 b	095.25 ab	131.32 a	079.74 b	098.97 a	1.20 a	0.33 a
Pendimethalin + Glyphosate	15.55 a	15.44 a	100.30 a	131.05 a	106.09 a	114.18 a	0.95 a	1.13 a
F-Test	**	**	**	**	*	**	ns	ns
LSD 0.05	1.40	1.45	28.83	25.85	23.22	25.16	———	———
0.01	1.85	1.92	38.07	34.13	30.67	33.23	———	———
Orthogonal contrast								
Control vs Others	**	**	**	**	*	**	*	ns
Pendi. vs Pendi. + Glyphosate	**	**	**	ns	*	ns	ns	ns
Gly. vs Pendi. + Glyphosate	**	**	**	ns	ns	**	ns	ns

*, **, 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 The Least Significance Test.*

[Y] *Abbreviations, for orthogonal contrasts, denote; Pendi = Pendimethalin, Gly = Glyphosate and Pendi + Gly = Pendimethalin + Glyphosate.*

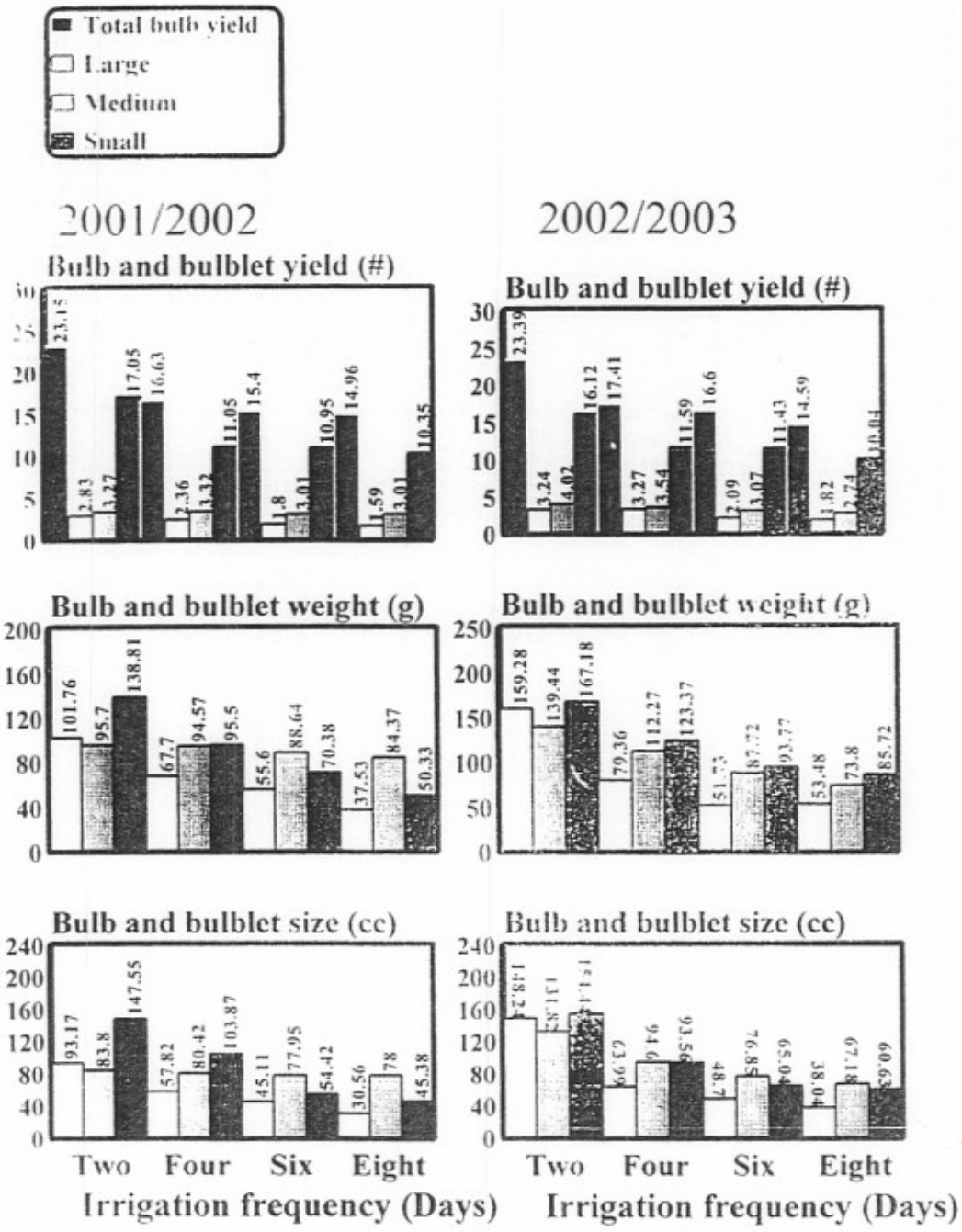

Fig. 1. Total bulb yield , bulb and bulblet yield (#), weight (g) , and size (cc), of large, medium and small bulbs, of tuberose clump, as influenced by irrigation frequencies, during the 2001/2002 and 2002/2003 growing seasons, at Hada AL-Sham's Agricultural Experimental Station, Makkah AL-Mokaramah Area, KSA.

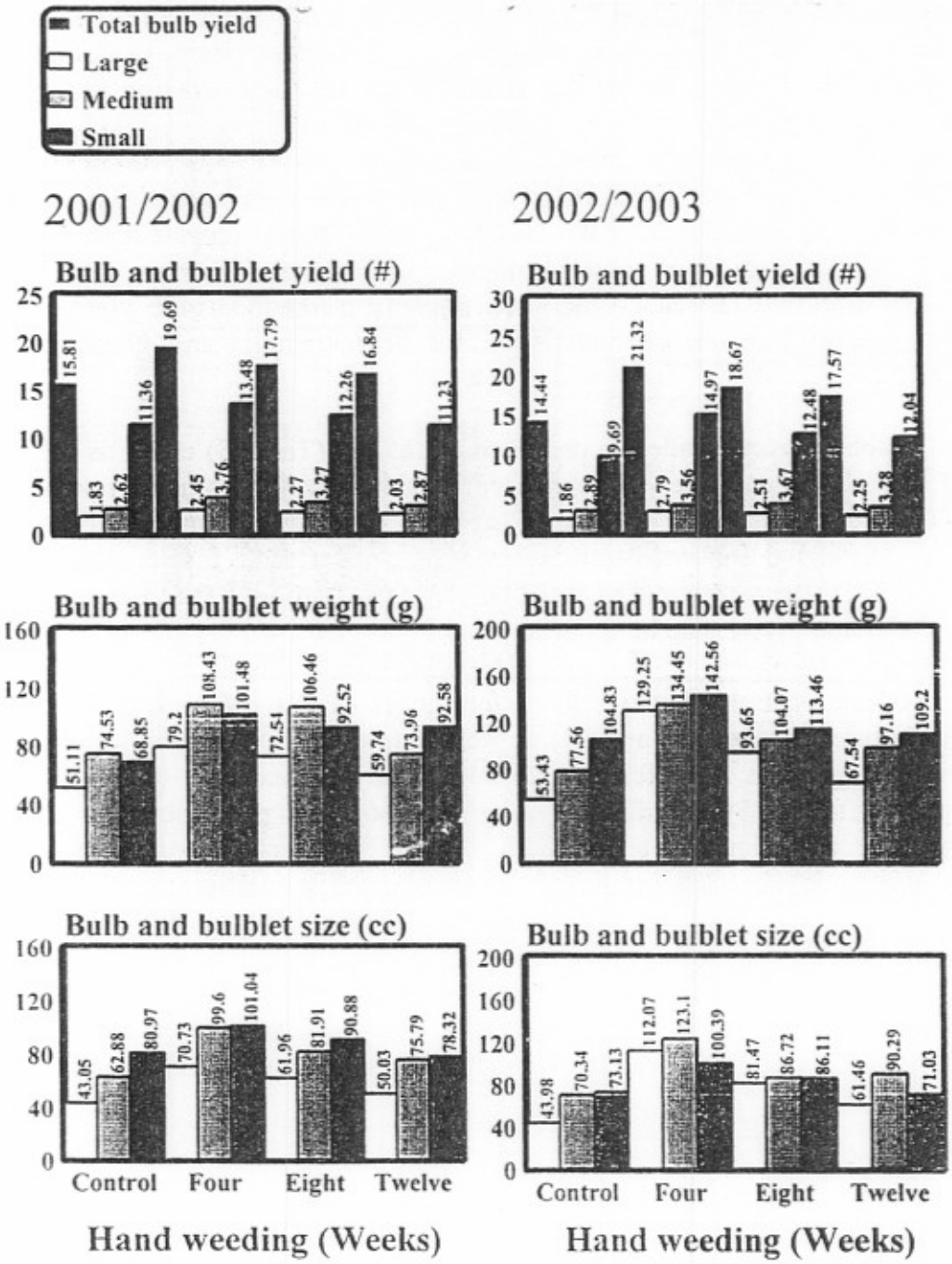

Fig. 2. Total bulb yield , bulb and bulblet yield (#), weight (g) , and size (cc) , of large, medium and small bulbs, of tuberose clump, as influenced by manual hand weeding, during 2001/2002 and 2002/2003 growing seasons, at Hada AL-Sham's Agricultural Experimental Station, Makkah AL-Mokaramah Area, KSA.

Medium bulbs or grade II bulbs and/or bulblet, as a category of the total bulb yield, yield as well as characteristic trait performances were profoundly influenced by the different herbicidal treatments, in the two growing seasons (Table 2). Pendimethalin, as a preemergence herbicide followed by glyphosate application, as a postemergence one, in the same sub-sub-plots immensely increased medium bulb yield, weight and size, compared to any herbicides, when applied alone, or even to the control. However, any of these separate herbicidal treatments was superior over the control. Orthogonal contrast way of comparisons disclosed immense synergistic impacts on medium bulb yield and associated weight and size characteristics, for pendimethalin and glyphosate herbicides.

Small bulblet cloves (grade III) produced per clump (Table 3) either as yield number or as weight and size were enhanced considerably, due to pendimethalin plus glyphosate applications, compared to other herbicidal treatments or the control. Orthogonal contrast, statistical way of comparisons, further revealed great synergistic effects on yield of small bulblet cloves produced per clump, for pendimethalin and glyphosate herbicides.

Figure 3 demonstrates behavioral performances of the different bulb and bulblet categories (grade I, II and III) as well as total bulb yield produced per clump, in both seasons. Manifestly, total bulb yield produced per clump were increasingly affected by pendimethalin, glyphosate and pendimethalin plus glyphosate, in ascending order, in both seasons compared to the control. Notably, bulb and/or bulblets (grade I & II) were fewer in number than those of small bulblet cloves produced per clump. In general, due to the different herbicidal treatments. However, there were conspicuous tendency, more or less, for equivalences in weight and size for low production of grade I and grade II and the production of grade III bulblet cloves. However, these were observed over almost all herbicidal treatments, especially pendimethalin plus glyphosate treatments.

The immense effects of the different herbicidal treatments, in particular pendimethalin plus glyphosate might be attributed to the dominant influences of pendimethalin plus glyphosate herbicides, as pre and post emergence herbicides catching almost all weeds competing with tuberose, according to EL-Naggar and Byari (2007 a &b). This might have allowed enhancement of bulb and bulblets growth and development, resulting in the noticeable performances of bulb and bulblet's yield, weight and size. However, herbicidal chemicals, such as pendimethalin as preemergence or glyphosate as postemergence were reported to significantly improve bulb and bulblet yield and production, in numerous ornamental bulbs, including tuberose (Pal & Das, 1990 and Panwar *et al.*, 2005); gladiolus (Bing *et al.*, 1988 Mynett & Jagusz, 1990 and Arora *et al.*, 2002); elephant foot yams (Bhaumik *et al.*, 1988); and iris (Ivanova, 1999).

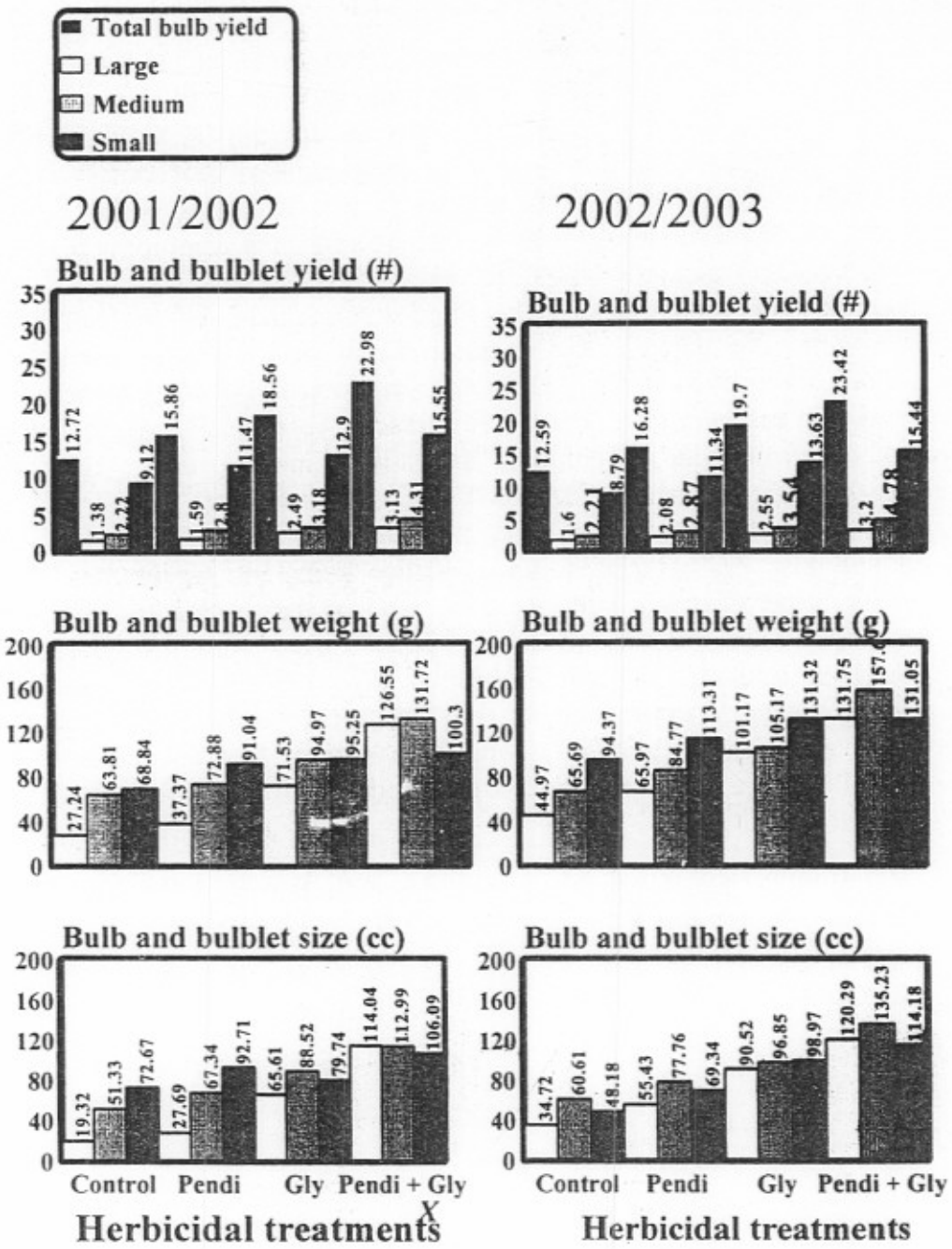

Fig. 3. Total bulb yield , bulb and bulblet yield (#), weight (g) , and size (cc) , of large, medium and small bulbs, of tuberose clump, as influenced by herbicidal treatments, during the 2001/2002 and 2002/2003 growing seasons, at Hada AL-Sham's Agricultural Experimental Station, Makkah AL-Mokaramah Area, KSA.

X *Abreviations, for the herbicidal treatments, denote; Pendi = Pendimethalin, Gly = Glyphosate and Pendi + Gly = Pendimethalin + Glyphosate.*

Impacts of irrigation frequency regimes x manual hand weeding x herbicidal Treatments interactive effects

Irrigation frequency regimes, manual hand weeding and the different herbicidal treatments, as main investigated factors, interacted mutually together and also with prevailing environmental conditions, resulting in highly significant, significant and non-significant second and/or third order effects, for tuberose, bulb and bulblets, produced per clump, in the two growing seasons (Table 4). However, the third order interactive effects is commonly meaningful, drawing the whole picture of the three investigated factors, when they coexisted together, although the tendency to be avoided sometimes, for hard and complex interpretation. Nonetheless, this manuscript may only focus on discussing the third order interactive effects. However, irrigation frequency regimes, manual hand weeding and herbicidal treatments interacted reciprocally together and with ambient environmental conditions, prevailing in the area, resulting in considerable effects, in the first growing season and either non significant or significant impacts, in the second one, on tuberose total bulb yield produced per clump and also on associated grade quality traits and parameters (Fig. 4) Obviously, tuberose total bulb yield as well as large (grade I) bulb yield produced per clump, grown in sub-sub-plots treated with glyphosate and/or pendimethalin plus glyphosate, mostly at any level of hand weeding and frequently irrigated every two and/or four days recorded noticeably higher yield than other treatments, particularly control. However, these effects were also manifested on large bulb weight and size, in both seasons.

Medium bulb yield produced per clump as well as weight and size were also enhanced due to pendimethalin plus glyphosate or glyphosate, at any weeding level and irrigation frequency every two or four days, especially in the second growing season (Fig. 5). Nevertheless, figure 6 demonstrates behavioral performances of small bulblet cloves, including yield, weight and size as influenced by the mutual interactive effects of irrigation frequency regimes, hand weeding and the different herbicidal treatments. Although small bulblet clove yield seemed to be enhanced, due to pendimethalin plus glyphosate or even glyphosate alone, at almost all weeding levels, particularly when watered frequently every two and/or four days, its weight as well as size were noticeably improved due to these treatments.

Generally, enhancement and/or improvement of bulb and/or bulblets produced per clump, including large, medium and even small bulblet cloves, due to interactive effects of the three investigated factors, when they coexisted together under such prevailing environmental conditions might be attributed to advantageous coexistence of all factors, beneficial to bulb and bulblet formation,

growth and development; herbicidal treatments, especially pendimethalin plus glyphosate as well as frequent hand weeding might have be capable of eliminating or at least minimizing emergent competing weeds, and comprehensive watering and/or irrigation every two or four days might have furnished excessively high available soil moisture, in the soil rhizosphere, rich in minerals and nutrients. All these factors may be responsible for such improvement in tuberose bulb and bulblet production associated with enhanced weight and size traits.

Pearson correlation analyses

Table 5 demonstrates Person correlation analyses, and coefficients among investigated traits and parameters of tuberose bulb and bulblet yield, weight and size, describing correlative relationships. It is worth notable that total bulb yield produced per clump, including large (grade I), medium (grade II) and small bulblet cloves (grade III) was positively correlated with large bulb yield, weight and size; medium bulb yield, weight and size; and small bulblet cloves weight and size. Conversely, it was negatively correlated with small bulblet cloves yield as number. These positive correlative interrelationships might be due to the fact that large, medium and even small bulblet cloves, regardless of tuberose rhizomatous clump, along with their associated quality characteristic traits, all constitute the formulation components of tuberose total bulb and bulblet yield produced. Hence, as total bulb yield increase, all components would accordingly increases. On the other hand, negative correlative relationship between total bulb yield and small bulblet cloves may be due to logical interpretation. Nevertheless, as small bulblet cloves increase in number, constituting the third category of total bulb yield, and also formulating the highest percentage of the components, the remaining components (large and medium bulb and bulblets) would subsequently decreases, thus total bulb yield decreases, revealing negative correlative performances. This was evidently obvious, revising yield production of all individual components of total bulb yield.

TABLE 4. Mutual interactive effects of irrigation frequencies, hand weeding, and herbicides on large, medium and smal bulb yield, weight, size and specific gravity performances, 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).

Large bulbs (avg.)/clump	Total bulb yield (#)		Large bulb yield (#)		Large bulb weight (g)		Large bulb size (cc)		Large bulb specific gravity (g/cc)	
Interactions	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	**	ns	ns
Irrigation x Herbicides	ns	**	**	**	**	**	**	**	ns	ns
Weeding x Herbicides										
Irrigation x Weeding x	ns	**	**	ns	**	**	**	**	**	ns
Herbicides	*	ns	**	ns	**	**	**	**	**	ns

Medium bulbs (avg.)/clump	Medium bulb yield (#)		Medium bulb weight(g)		Medium bulb size (cc)		Medium bulb specific gravity (g/cc)	
Interactions	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	**	ns	ns
Weeding x Herbicides								
Irrigation x Weeding x	ns	ns	ns	**	**	**	ns	ns
Herbicides	ns	**	ns	**	ns	**	ns	ns

Small bulbs (avg.)/clump	Small Bulb Yield (#)		Small Bulb Weight (g)		Small Bulb Size (cc)		Small Bulb Specific gravity (g/cc)	
Interactions	2001/02	2002/03	2001/02	2002/03	2001/02	2002/03	2001/02	2002/03
Irrigation x Weeding	ns	**	ns	**	ns	**	ns	ns
Irrigation x Herbicides	ns	*	*	*	*	ns	ns	ns
Weeding x Herbicides								
Irrigation x Weeding x	ns	**	**	ns	*	ns	ns	ns
Herbicides	ns	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.*

TABLE 5. Pearson correlation coefficients of tuberose total bulb and bulblet yield per clump, and bulb & bulblets grade parameters, as functions of 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/ clump (avg.) [a]	Total bulb yield	Large bulb yield (#)	Large bulb weight (g)	Large bulb size (cc)	Medium bulb yield (#)	Medium bulb weight (g)	Medium bulb size (cc)	Small bulb yield (#)	Small bulb weight (g)	Small bulb size (cc)
Total bulb yield	———	0.67**	0.59**	0.61**	0.45**	0.36**	0.47**	- 0.95**	0.29**	0.43**
		0.81**	0.73**	0.76**	0.56**	0.63**	0.58**	- 0.97**	0.36*	0.48**
Large bulb yield (#)		———	0.70**	0.73**	0.52**	0.39**	0.54**	0.47**	0.23**	0.30**
			0.77**	0.78**	0.50**	0.66**	0.60**	0.71**	0.26**	0.47**
Large bulb weight (g)			———	0.88**	0.49**	0.42**	0.44**	0.44**	-0.006 ns	0.18**
				0.88**	0.42**	0.62**	0.61**	0.67**	0.25**	0.39**
Large bulb size (cc)				———	0.47**	0.38**	0.47**	0.47**	0.08 ns	0.14*
					0.42**	0.63**	0.58**	0.72**	0.24**	0.33**
Medium bulb yield (#)					———	0.41**	0.68**	0.18**	0.09 ns	0.11 ns
						0.55**	0.51**	0.36**	0.15*	0.19*
Medium bulb weight (g)						———	0.43**	0.25**	-0.42**	0.13*
							0.88**	0.53**	-0.04 ns	0.05 ns
Medium bulb size (cc)							———	0.29**	0.08 ns	-0.07 ns
								0.49**	-0.008 ns	-0.04 ns
Small bulb yield (#)								———	0.28**	0.43**
									0.36**	0.47**
Small bulb weight (g)									———	0.24**
										0.44**
Small bulb size (cc)										———

ns, *, ** Indicate non significant, significant and highly significant at the 0.05 and 0.01 Levels of Significance.

[a] The upper coefficients denote 2001/2002, and the lower ones indicate the 2002/2003 growing seasons, respectively.

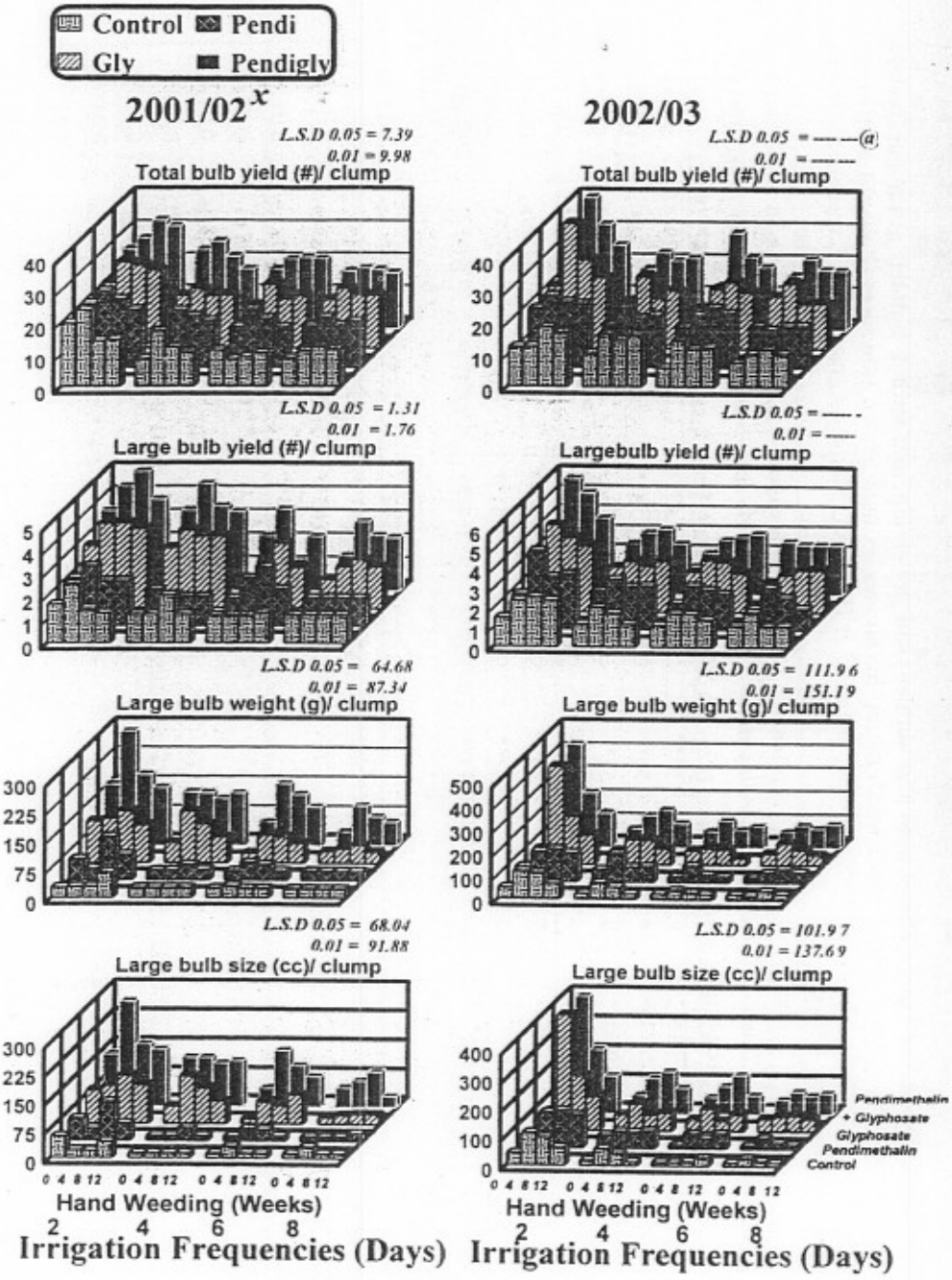

Fig. 4. Tuberose total bulb yield/clump, average large bulb yield, weight and size per clump, as Influenced by the mutual interactive effects of irrigation frequencies, manual hand weeding and herbicides, during the 2001/02 na d2002/03 growing seasons, at Hada AL-Sham's Agricultural Experiment Station (Makka AL-Mokaramah AREa, KSA).

X Abbreviations, of treatments, in the series Denote; Pendi=Pendimethalin, Gly = Glyphosate and Pendimethalin+ Glyphosate

@ The L.S.D was not not determined, because F test was not significant, at the 0.05 level of significance. Figures were illustrated, however, to describe data performances during the confirming growing season, in comparison to the other one.

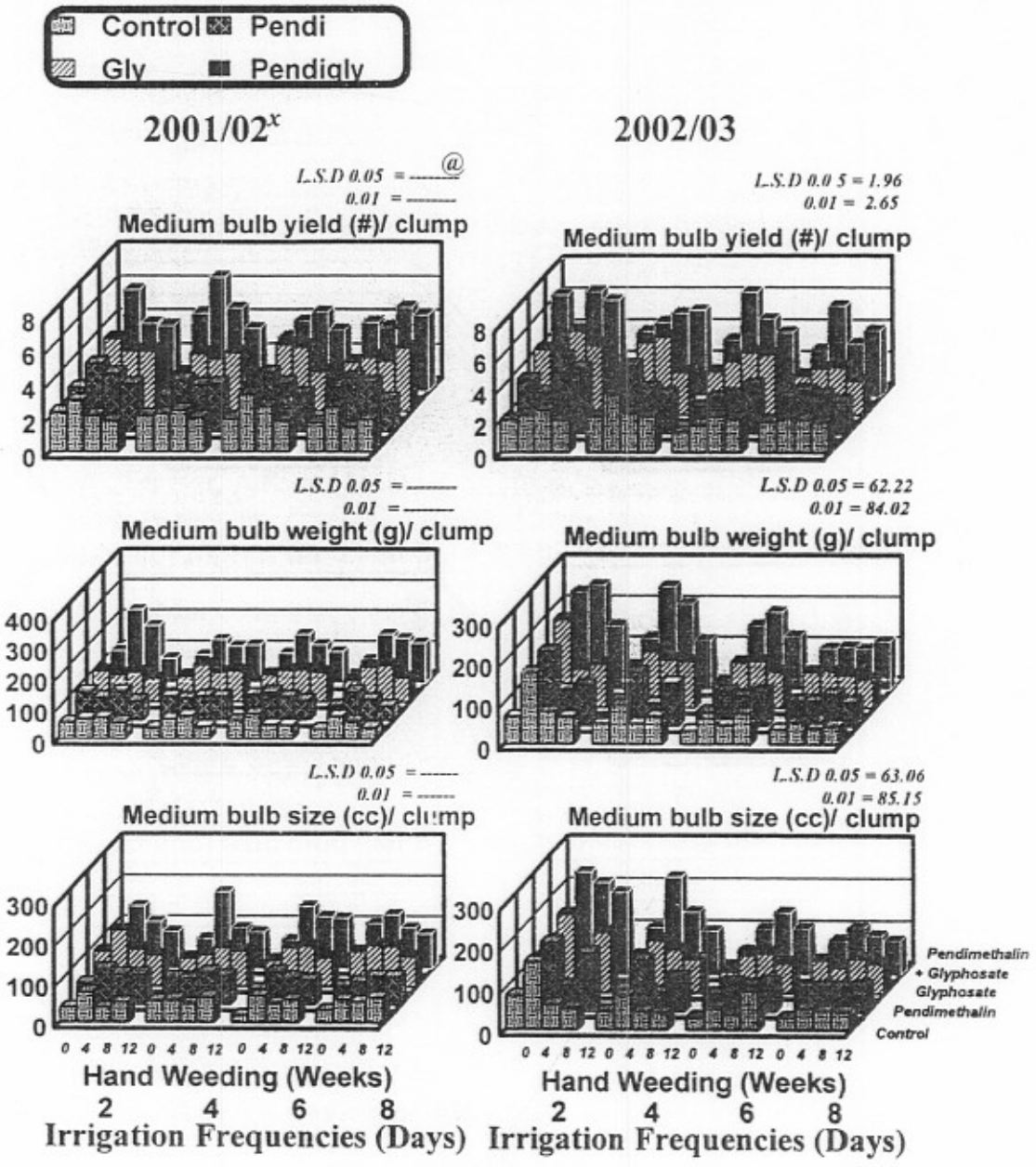

Fig. 5. Average medium bulb yield (#) , weight (g), and size (cc), per clump, as Influenced by the mutual interactive effects of irrigation frequencies, manual hand weeding and herbicides, during the 2001/02 and 2002/03 growing seasons, at Hada AL-Sham's Agricultural Experiment Station (Makkah AL-Mokaramah Area, KSA).

X Abbreviations, of treatments, in the series Denote; Pendi=Pendimethalin, Gly = Glyphosate and Pendimethalin+ Glyphosate

@ The L.S.D was not not determined, because F test was not significant, at the 0.05 level of significance. Figures were illustrated, however, to describe data performances during the confirming growing season, in comparison to the other one.

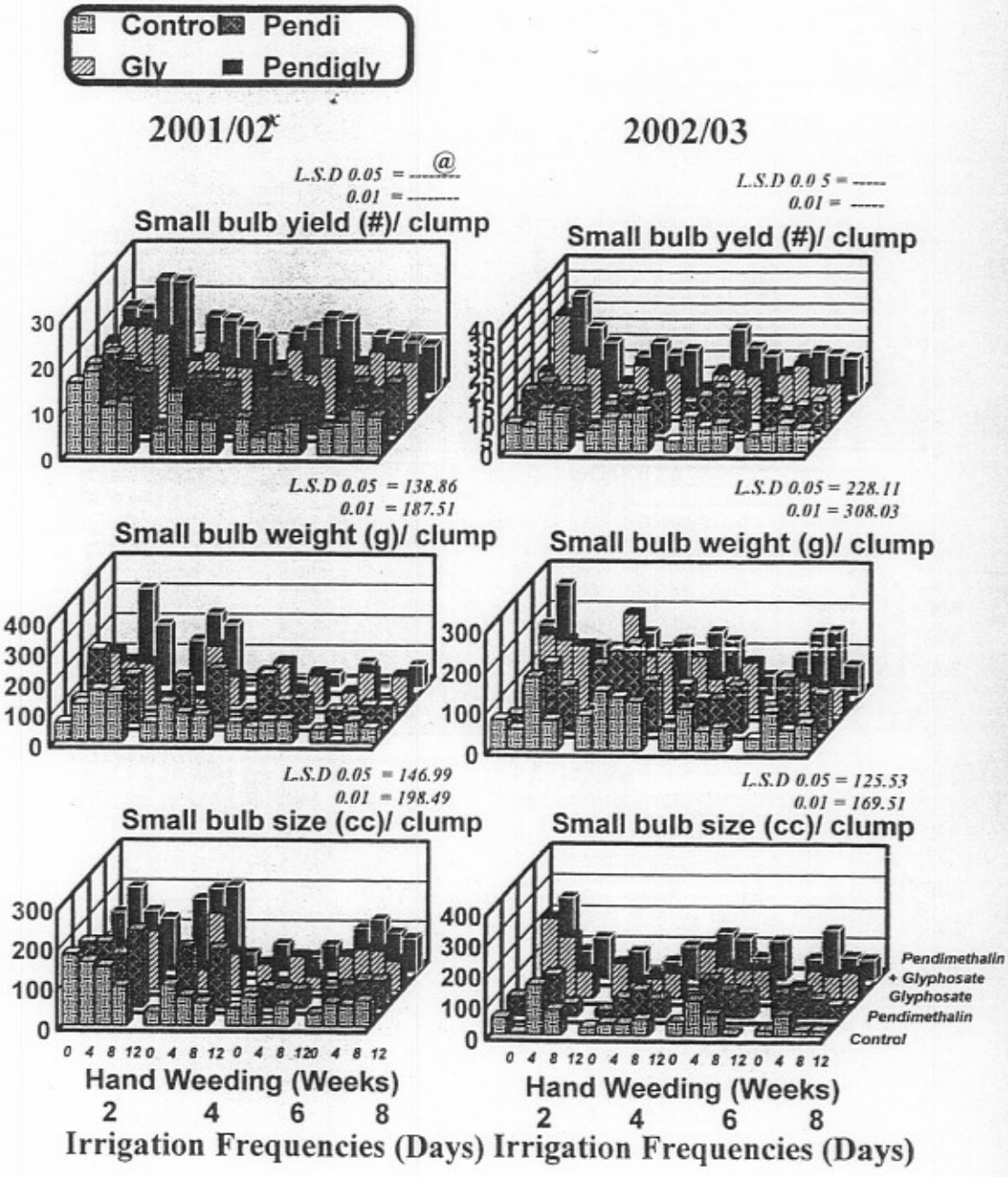

Fig. 6. Average medium bulb yield (#) , weight (g), and size (cc), per clump, as Influenced by the mutual interactive effects of irrigation frequencies, manual hand weeding and herbicides, during the 2001/02 and 2002/03 growing seasons, at Hada AL-Sham's Agricultural Experiment Station (Makkah AL-Mokaramah Area, KSA).

X Abbreviations, of treatments, in the series Denote; Pendi=Pendimethalin, Gly = Glyphosate and Pendimethalin+ Glyphosate

@ The L.S.D was not not determined, because F test was not significant, at the 0.05 level of significance. Figures were illustrated, however, to describe data performances during the confirming growing season, in comparison to the other one.

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تأثير تكرارات الرى ومقاومة الحشائش على أداء وسلوك نباتات التيوبروز المزروعة في الحقل ، بالمنطقة الغربية للمملكة العربية السعودية :
٢ . محصول أبصال وبصيلات الجور البصلية ومواصفات الجودة النوعية

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تعني هذه الدراسة بإلقاء الضوء على محصول أبصال وبصيلات الجور البصلية المنتجة و صفاتها وكذلك مدى جودتها ، كوحدات إكثارية مرتقبة أو مستقبلية لهم مزارعي ومنتجي التيوبروز ، من خلال دراسة أنسب معدلات تكرارات الرى وأنسب السبل لمقاومة الحشائش يدويا أو باستخدام مبيدات الحشائش ، خصوصا تحت ظروف البيئة الجافة بالمنطقة الغربية للمملكة العربية السعودية. ولذلك أجريت تجربة حقلية في تصميم القطع المنشقة المنشقة ، ذات نظام القطاعات العشوائية الكاملة، في أربعة مكررات ، وذلك لدراسة تأثيرات تكرارات الرى (الرى 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 طهور

الحشائش)، جليفوسات (ما بعد الظهور) ، بنديميثالين (قبل الظهور) + جليفوسات (بعد الظهور) } ومدى تأثير ذلك على محصول الأبصال والبصيلات ومواصفاتها ومدى نموها وتطورها وكذلك صفات الجودة ، وذلك خلال موسمى ٢٠٠١/٢٠٠٢ و ٢٠٠٢ / ٢٠٠٣ ، وكانت أهم النتائج كالتالي:

- أدى استخدام الرى المتكرر كل يومين إلى زيادة المحصول الكلي للأبصال المنتجة بالنسبة للجورة زيادة معنوية .

- أدى استخدام هذه المعاملة أيضا الى زيادة محصول أبصال الدرجة الأولى وكذلك وزنها وحجمها ، في كلا الموسمين وذلك عند مقارنتها بمعاملات تكرارات الرى الأخرى، كما حسنت من محصول وصفات بصيلات الدرجة الثانية أوالمتوسطة وخاصة في الموسم الثاني.

- أنتجت هذه المعاملة أيضا أعلى محصول من بصيلات الدرجة الثالثة الصغيرة أو الفصوص وكذلك الوزن والحجم وذلك عند مقارنتها بمعاملات الرى الأخرى.

- أدت معاملة مقاومة الحشائش يدويا كل أربعة أسابيع الى زيادة واضحة وملموسة في المحصول الكلي للجورة ، وذلك بالمقارنة بالمعاملات الأخري للمقاومة اليدوية ، بما فيها معاملة الكنترول ، وذلك في كلا الموسمين .

- أدت معاملات المقاومة اليدوية للحشائش كل أربعة أو ثمانية أسابيع إلى زيادة معنوية في محصول أبصال وبصيلات الدرجة الأولى والثانية وكذلك تحسن في وزنها وحجمها في كلا الموسمين ، عند مقارنته بالمقاومة اليدوية كل إثنى عشر إسبوعا أو معاملة الكنترول.

- أدت معاملة المقاومة اليدوية للحشائش كل أربعة أسابيع إلي تحسين إنتاجية البصيلات الصغيرة أو الفصوص وكذلك وزنها وحجمها بالمقارنة بمعاملة الكنترول في كلا الموسمين.

- أدى استخدام البنديميثالين كمبيد ماقبل ظهور الحشائش مع الجليفوسات كمبيد مابعد الظهور إلى زيادة في المحصول الكلي للجورة وذلك بالمقارنة بأى مبيد استخدم منفردا أو الكنترول ، في كلا الموسمين.

- أنتجت الوحدات التجريبية التي عوملت بالبنديميثالين مع الجليفوسات أعلى محصول من أبصال الدرجة الأولى وذات وزن وحجم كبيرين ، وذلك بالمقارنة بأى مبيد استخدم منفردا أو حتى الكنترول ، في كلا الموسمين ، كما حسنت هذه المعاملة أيضا من محصول الدرجة الثانية والثالثة أو الفصوص الصغيرة ووزنها وحجمها.

- على الرغم من أن الجور البصلية أنتجت بصفة عامة محصول قليل من أبصال الدرجة الأولى والثانية وذلك بالمقارنة بمحصول الدرجة الثالثة أو الفصوص الصغيرة إلا أنها كانت إلى حد ما متقاربة معها في الوزن أو الحجم.

- أدى استخدام الجليفوسات منفردا أو البنديميثالين مع الجليفوسات ، عند أى من مستويات المقاومة اليدوية مع استخدام الرى المتكرر كل يومين أو أربعة أيام إنتاج محصول عالي من الأبصال والبصيلات بالمقارنة بالمعاملات الأخرى وخاصة معاملة الكنترول.

- أسفرت تحاليل بيؤسون للتلازم والإرتباط عن وجود علاقة تلازمية موجبة بين المحصول الكلي للأبصال للجورة (أبصال وبصيلات درجة أولى وثانية وثالثة) و كل من أبصال الدرجة الأولى والثانية والثالثة ووزنها وحجمها ، بينما كانت هناك علاقة تلازمية سالبة مع محصول بصيلات الدرجة الثالثة أو الفصوص الصغيرة.