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WEED CONTROL IN FIELD GROWN TUBEROSES (*Polianthes tuberosa, L .*) CV. 'DOUBLE', IN THE WESTERN REGION ARID ZONE OF SAUDI ARABIA: A. WEED POPULATION DENSITY, GROWTH PERFORMANCES AND TUBEROSE CUT FLOWER YIELD, AS FUNCTIONS OF IRRIGATION FREQUENCIES, HAND WEEDING AND HERBICIDES

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Abstract: Weeds represent a major confronting challenge, in field-grown tuberoses, under furrow irrigation system, in the Western Region of Saudi Arabia, which hamper ameliorating tuberose cut flower yield and qualities as well as bulb production. Consequently, a Split-Split-Plot field experiment, in Complete Randomized Block Design, with four replicates, was performed, at Hada AL-Sham's Agricultural Experiment Station (Macca AL-Mokarama Area, KSA) during the 2001/02 and 2002/03 growing seasons, to resolve this problem; Irrigation frequencies (irrigation after 2, 4, 6 and 8 days) comprising the whole plots; manual hand weeding (unweeded control, weeding after 4, 8, and 12 weeks) represented the sub-plots; and Herbicidal treatments (control, Pendimethalin, glyphosate and Pendimethalin plus glyphosate) in the sub-sub-plots. The most predominant and highly prevalent weed species were *Cynodon dactylo*n and *Cyperus rotendus*. Nevertheless, *Convolvulus arvensis*, *Malva sylvestris, Portulaca oleracea*, *Amaranthus viridis, Solanum nigrum, and Amaranthus sylvestris* exhibited relatively medium pervasiveness. Low weed prevalence and associations of *Anagalis arvensis, Chenopodium murale, Chenopodium glaucum*, *Echinochola crusgalli, Eclipla prostrata, Setaria verticillata, Cirisium arvense, Lolium multiflorum, Farsetia aegyptia, Brassica tournefortii, and Flavera trinervia* were also observed.

High available soil moisture and frequent irrigations every two days, increased weed population density, fresh and dry weights, water use efficiency on dry weight basis, and weed control efficiency considerably, in comparison with stress conditions and irrigation every eight days, in both seasons.

Manual hand weeding every 4 and 8 weeks immensely reduced weed density, fresh and dry weights, water use efficiencies, and greatly increased weed control efficiency, in comparison with the unweeded control, in the two growing seasons.

All herbicidal treatments significantly reduced weed parameters. Pendimethalin plus glyphosate reduced weed density, fresh and dry weights, weed water use efficiencies, and noticeably increased weed control efficiency, in both seasons (86.9 and 93.68), respectively, in comparison to the untreated controls.

Tuberose cut flower yield production favored comprehensive frequent irrigations, as well as frequent manual hand weeding. Pendimethalin plus glyphosate considerably improved cut flower yield production, in comparison with either the untreated control or each herbicide applied alone. Yield of tuberose cut flowers was negatively correlated with weed water use efficiencies and positively correlated with weed control efficiency, in both seasons.

Additional Index Words: Tuberose, Polianthes tuberosa, L. cv "Double", Weeds, Irrigation Frequency, Water Use Efficiency, Hand Weeding, Herbicides, Pendimethalin, Glyphosate, Weed Control, Weed Control Efficiency.

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Introduction: Tuberose or Omixochitl (*Polianthes tuberosa, L.*), Family *Agavaceae*, which was cherished and cultivated earlier in Mexico, even before the conquest in 1522, is one of many flowers which have come to us from the ancient culture of the Nahuatl-speaking peoples (Trueblood, 1973). The native Mexican white and luminous flowering spikes of tuberose, with its sweet lingering fragrance are in great demand and commercially produced as lovely summer blooming cut flowers in West Bengal-India, and metropolitan cities all over the World (Armitage and Laushman, 1990; and Singh, 1995). This adorable cut flower crop was enthusiastically introduced into the Saudi Arabian Western Region, hoping establishment, acclimatization and aiming to diversifying floricultural crops in the area. Successful adaptation and acclimatization were achieved and applied research programs were initiated for improvement and amelioration (El-Naggar and Byari, 1999 a, b, c, and d). However, Tuberose essentially required additional researches to overcome high productivity constrains and obstacles. Water deficiency and depletion of irrigation water may cause severe water stress and drought in arid and semiarid zones in Saudi Arabia, in particular, where rainfall is minimal and does not surpass 100 ml/annum average precipitation, according to Hussein and Bazuhair, 1992; and Al-Dubaikhi, 1999. Consequently, implementation of irrigation water conservation program(s) and water use rationalization were extremely vital and mandatory for investigation, under the prevailing conditions. Irrigation frequency and water regime studies revealed very beneficial effects of irrigation and watering to numerous bulbous ornamentals (Papaneck, 1992; El-Naggar and Nassar, 1994; Dandria *et al.*, 1996; and Halepyati *et al.*, 2002). Nevertheless, many researches and investigations revealed that, increasing irrigation levels and/or irrigation frequencies not only encouraged weed population intensities and dry matter accumulations, but also extended the period of emergence, promoted the regularity of developmental stages, and considerably hastened seed-weed dispersal in large number of weed species, in different crops including potatoes (Armellina and Zimdahl, 1989; and Mirabelli *et al*., 2005). Consequently, integrated and/or agrochemical weed control strategies, in field grown tuberoses were urgently required.

Weed infestation represents a major challenging problem in Saudi Arabia. Several attempts were conducted to control weeds in different crops such as tomatoes, carrots, wheat, etc.. (Tag-El-Din *et al*., 1997; and Al-Turki and Abdul Ghafoor, 1996) in The Kingdom. However, The most comprehensive definition of weed is the plant whose virtues have not been discovered so far (Abdul Ghaffoor, 2004). Weeds, according to Webster's New World Dictionary (Guralnik, 1978), are defined as any undesired uncultivated plants, especially those growing in profusion so as to crowed-out a desired cultivated crop. Weeds have multiferous ways of competing and interfering with crop growth and crop culture. It compete with crops for one or more plant growth factors such as mineral nutrients, water, solar energy and space and they hinder crop cultivation operations. Moreover, it harbors insect pests and diseases, resulting in reducing crop yield and impairing the qualities (Derr, 2004; and Zimdahl, 2004).

Hand weeding and/or hoeing, as a weed control approach, was proven very efficient in controlling weed population and intensities, although it is very costly, laborious, exhausting and backbreaking, particularly in developing countries allover the World. Many researchers and investigators working with bulbous ornamentals reported that frequent hand weeding immensely reduced weed total population, intensity and weed dry weights, in field grown tuberoses (Mohanty *et al*, 2002; and Panwar *et al*, 2005); gladioli (Chahal *et al*, 1994; Widaryanto *et al*, 1997; and Cheong *et al*, 2000); German Iris (Pennucci, 2000); Crocus (Bullitta *et al*., 1996); Santosa *et al*, 2006); as well as non flowering bulbs, such as Potatoes (Mirabelli *et al*., 2005).

Herbicidal weed control strategy is considered as the most effective and efficient cultural practice, in many countries allover the world, due to easier applicability and being considerably cheaper costewise, in comparison to hand weeding tribulations (Mehmood *et al*., 2007). Preemergence as well as postemergence herbicides and/or their combinations have long been successfully and extensively, used, as alternative and supplementary approaches, for controlling weeds, in numerous flowering bulb plantations, everywhere in the World. Pendimethalin (*N-(1-ethylpropyl)-2,6-dinitro-3,4-xylidine*) is considered as one of the most successful selective preemergence herbicide used to control most annual grasses and some broadleaf weeds, according to herbicidal handbook committee (WSSA, 1989). It is used as preemergence and early postemergence herbicide incorporated into the soil by cultivation or irrigation, within 7 days following application. It strongly absorbs to soil organic matter and clay particles and it does not leach through the soil to contaminate ground water. Pendimethalin herbicidal effects and mode of action are related to the inhibition of cell division and cell elongation through preventing tubulin from polymerizing into microtubules, resulting in inhibiting mitosis (Hatzinikolaou *et al*., 2004). The plant root and shoots absorb it, easily. However, once it was absorbed into plant tissues, translocations became limited and it breaks down via oxidation. Nevertheless, residues on crops at harvest are usually below the detectable levels (0.05 ppm) (WSSA, 1989). Nonetheless, Pendimethalin application at rates ranging from 0.50 to 4.50 kg a. i/ha, resulted in excellent weed control of broad leaves and grassy weeds, and greatly reduced weed population, intensity and dry weights, in many ornamental flowering bulbs and herbaceous perennials, including tuberose (Murthy and Gowda, 1993); Gladiolus (Kwon *et al*., 1996; Misra, 1997; Sunil-Kumar *et al*., 2001; Arora *et al*., 2002; and Richardson and Zandstra, 2006); Tulip (Al-Khatib, 1996); Iris (Ivanova, 1999); and numerous herbaceous perennials (Calkins *et al*., 1996).

Glyphosate *(N -(Phosphonomethyl) glycine)* is also considered as one among the World's most widely used post-emergence herbicides, in agriculture. It is a broad-spectrum, non-selective systemic herbicide used for controlling annual and perennial plants, including grasses, sedges and broad-leaved weeds (Kidd and James, 1991). Glyphosate, mode of action, functions through inhibiting protein biosynthesis, via blocking the activity of a specific enzyme used by plants to make certain important amino acids. Without these amino acids, however, the plant cannot synthesizes proteins required for various life processes, resulting in the death of a plant (Eason *et al.,* 2000; and Cox, 2004). This herbicide has been authorized for uses in ornamental bulbs, in the Netherlands, in the early seventies, according to Rooy and Kosler, 1978, at a recommended rate of 6 L/600 L water/ha, depending on weed sizes. It was found very effective in controlling wide spectrum of perennial weeds (Miller *et al*., 1981), particularly grasses, such as *Cyperus spp*, through the formation of one layer of sclerenchymatic cells between roots and rhizome primordia and the cortical tissues, which perhaps could play an important role in the inhibition of rhizomes and roots emergence by the herbicides (Canal *et al*., 1989). Panwar *et al*., 2005, found that glyphosate at a rate of 2.0 a. i. % efficiently minimized weed intensity and population and greatly reduced weed dry weights, in field grown tuberoses. It also lowered weed count, dry weights and increased weed control efficiency in field grown gladiolus, according to Chahal *et al*., 1994; and Manuja *et al*., 2005.

This investigation was initiated to investigate weed population growth, performances and tuberose cut flower yield as influenced by irrigation frequencies, hand weeding and Pendimethalin, Glyphosate and their combinations, as pre and post emergence weed control herbicides, in field grown tuberoses, under the Western Region Arid Zone conditions of Saudi Arabia.

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, 2002/2003.

Plant Materials

Tuberose bulbs (*Polianthes tuberosa, L.*) cv. "Double", or the pearl, were imported as clumps, from Abaadeia, Warak-Giza, Arab Republic of Egypt. Clumps were individually divided by hand to either bulbs or bulblets with all possible sizes and weights, using Varnier calipers and balances, screened, then grouped and categorized together into different categories and ultimately counted.

Investigation Insight & Experimental Layout

A main outdoor investigation was initiated and launched, to evaluate the performances of weed population growth and intensity, in field grown tuberoses, under the Western Region Arid Zone conditions, in a Horticultural Agrotechniques Strategies Project (HASP) for ameliorating tuberose, through investigating the impacts of irrigation frequencies, manual weeding, and weed control treatments.

The experimental design and layout was set up as split-split-plot, in complete randomized block design, in four replicates, with a 1.5 x 2 meter experimental plot (experimental unit). The irrigation frequencies or watering intervals treatments (irrigation after two, four, six and eight days) were randomly assigned to the whole plots (48 m^2). The sub-plots, however, were, indiscriminately, assigned to the manual weeding treatments (control (no weeding), every 2, 4 and 6 weeks) and the sub-sub-plots were randomly assigned to the weed control herbicidal treatments (control, Pendimethalin, glyphosate, and Pendimethalin + glyphosate). Each experimental unit (sub-sub-plot) was planted with 24 tuberose bulbs (4 rows x 6 columns) of 3.5-4.5 cm in diameter, at distances of 25 x 30 cm.

Experimental Site Preparations and Bulb Planting

Soil was deeply ploughed, using tractors, in all directions, harrowed, cleaned from rocks, evenly mannured with compost as a basic dose at the rate of 10 Ton/ha, irrigated, and then subjected to solarization, for several days. These sequential operations were repeated several times, to initially, infertile the poor soil with a base organic matter, and to enhance its structure. The experimental site was planned and designed, according to the preplanned layout of the intended investigation, to include experimental plots of 1.5 x 2 meter each. 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.

Tuberose bulbs ranging sizes (3.5 – 4.5 cm) in diameter, and 38-55 g average weights, were subjected to planting on April 28*th*, 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 fertilizer, 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.

Experimental Site Soil Characterizations

Several laboratory and field tests and studies were conducted at the field experimental site, including soil mechanical, chemical analyses and determination of field capacity.

Soil Mechanical Analysis:

Three representative samples were collected from each soil depths (0-15 and 15-30 cm.) out of thirty experimental site locations, at the experimental farm, to characterize and determine soil texture of the field sites. These three samples per depth were pooled together for each location (thirty location). Samples/depth of these thirty locations were evenly pooled inclusively to yield a homogeneous representative sample for each depth. Each depth sample soil texture, at the experimental site, was found to be loamy sand, using the hydrometer method (Jackson, 1973).

Table (1): Soil Mechanical Analysis of Tuberose Experimental Site.

Depth	Coarse Sand(%)	Medium Sand (%)	Fine Sand(%)	Silt(%)	Clay (%)	Texture
0-15	56-70	00-14	06-10	1-11	8-40	Loamy Sand
15-30	00-53	10-41	15-45	13-90	7-24	Loamy Sand

Soil Chemical Analysis

Soil chemical analyses for tuberose experimental site were also conducted for cations and anions, nitrogen, phosphorus, potassium and organic matters (Table 2, and 3). Soil chemical analyses were performed following Jackson 1973.

Table (2): Soil Chemical Analyses for Tuberose Experimental Site (meq/l)

Depth(cm)	Cations (meq /l)				Anions (meq /l)				E.C mm/cm	pH
	K	Na	Ca	Mg	SO_4	Cl^-	HCO_3^-	CO_3^{--}		
0-15	0.72	6.14	1.82	0.67	2.71	70.56	16.11	0.20	2.77	8.25
15-30	0.72	8.22	2.6	0.93	2.91	77.7	15.41	0.00	3.12	7.80

Table(3): Nitrogen, Phosphorus and Potassium Concentration (mg/kg), and Organic Matter (%), at Tuberose Experimental Site

Depth (cm)	Nitrogen	Phosphorus	Potassium	Organic Matter (%)
0-15	0.32	0.13	2.50	0.479
15-30	0.30	0.11	2.50	0.883

Field Capacity at Tuberose Experimental Site

Field capacity was determined, in tuberose experimental site using a field plot, well irrigated through flood irrigation, covered with weed to eliminate evaporation, and left out for 48 hours. The percentage of moisture content were estimated in two experimental locations using three samples per location, to yield the field capacity in both locations as 15.7 and 16.32, respectively. Therefore, the field capacity in tuberose experimental site was estimated to be 16.00%. However, calculations were performed to estimate the amount of water required, each time for irrigation, to allow soil to reach the field capacity in the whole unit as 3.00 m^3 in the experiment.

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-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; after 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, 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, for weed population study, which took 180 days until harvesting weeds and recording data, consumed 11.25, 5.63, 3.75 and 2.81 cubic meter of water per whole plot, during the entire 180 days, respectively, in correspondence with irrigation after 2, 4, 6 and 8 days on sequence. However, irrigational treatments and watering intervals scheduling was 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 sprouting 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, sub-plots weeded every eight weeks, 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 resuspend 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 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

Weed Growth Population Parameters Measurements and Weed Control Efficiency

Data measurements were recorded for weeds in the different experimental sub-sub-plots in both seasons, 180 days after planting. Scale of Abundance: numerical abundance or frequency scale of the different infested weeds was performed according to (ZMSPS); The Zurich-Montpellier School of Phyto-Sosiology (Braun-Blanquet, 1964). This scale depends on actual field observation and visual rating of weed frequency of abundance and prevalence, in field grown tuberoses, particularly those of untreated sub-sub-plots; 20 % existence of a specific weed species was given the symbol * (very low), ** (low) represent 40 %, *** (medium) represent 60 %, **** (high) represent 80 %, and ***** (very high) represent 100 % abundance and/or existence. Weed intensity (density) or weed count, with careful hand or manual pulling, was performed per sub-sub-plots (3.0 m^{-1}) for all experimental units. Weeds of each experimental sub-sub-plots were freshly weighed in kg. Weed dry weights were also performed. Water use efficiencies were also calculated based on either number of weeds produced or unit dry weight per sub-sub-plot per cubic meter of water. Efficiency of weed control was determined according to the formula WCE (%)= 100 – (A/B * 100), where A= dry weight of weeds in a treated sub-sub-polt, and B= dry weight of weeds in the untreated controls, according to Balah *et al*., 2006. At the end of the flowering season, cut flower yield produced was surveyed and subjected to statistical analyses.

Statistical analyses

Statistical analyses were performed using the General linear Model (*GLM*) procedure, along with the regular analysis of variance, SAS computer package, and MSTAT computer Program (SAS, 1978; Steel and Torrey, 1980; and Freed *et al*., 1985). Orthogonal polynomial regression analyses, for the equally spaced categories factor, using polynomial coefficients (Gomez and Gomez, 1984), were performed to describe response curves (linear, quadratic and cubic) of weeds different traits, using the Sigma Plot Scientific Graphing System (SPSGS).

Results and Discussions

Weed Prevalence & Associated Weeds

Tuberose experimental field was infested mostly with broadleaves and some grassy weeds (Table 4). Numerical scale of abundance and frequency based upon actual field observation and visual rating revealed that, the most predominant and highly prevalent weed species were *Cynodon dactylon* and *Cyperus rotendus*. Nevertheless, *Convolvulus arvensis, Malva sylvestris, Portulaca oleracea, Amaranthus viridis, Solanum nigrum,* and *Amaranthus sylvestris* exhibited relatively medium pervasiveness. Low weed prevalence and association of *Anagalis arvensis, Chenopodium murale, Chenopodium glaucum, Echinochola crusgalli, Eclipla prostrata, Setaria verticillata, Cirisium arvense, Lolium multiflorum, Farsetia aegyptia, Brassica tournefortii, and Flavera trinervia* were also observed. However, some broadleaf weeds and some grassy ones such as *Lolium rigidum, Phalaris minor, Avena fatua, Raphanus spp, Melilotus indicus, Digera muricata, Sonchus oleracous, and Heliotropium supinum* registered the lowest prevalence and ubiquitousness.

Impacts of Irrigation Frequencies

Weed Population Density, Fresh and Dry Weights

Table (5) demonstrates emerged weed population density, fresh and dry weight's performances, in field grown tuberoses, as influenced by irrigation frequency treatments. The different irrigation frequencies exhibited highly significant impacts on weed population density, fresh and dry weights, according to F-test of significance. Frequent irrigations every two days increased weed density, fresh and dry weights considerably, in comparison with irrigation every eight days, in both seasons, according to the least significant differences mean comparison and separation. However, it is worth notable that increasing watering intervals or reducing irrigation frequency resulted in noticeably immense reduction in weed population intensity as well as its fresh and dry biomass. Orthogonal polynomial regression analyses with one single degree of freedom (Table 5 & Fig. 1) also yielded either significant or highly significant linear and/or quadratic responses. It clearly described these quadratic trends and performances with high R^2 values. Obviously, intensive frequent irrigation every two days may increase soil moisture content and

Table (4): Commonly Identified prevalent Weeds, infesting Field Grown Tuberoses, at Hada Al-Sham's Agriculture Experimental Station, Mecca Al-Mokaramah Area, in the Western Region of Saudi Arabia.

Numb	Common Name	Scientific Name[Y]	Family	Prevalence
1	Scarlet Primpernel	*Anagalis arvensis***	Primulaceae	Low
2	Field Bindweed	*Convolvulus arvensis****	Convolvulaceae	Medium
3	Goose Foot	*Chenopodium murale***	Chenopodiaceae	Low
4	Cheese Weed	*Malva sylvestris****	Malvaceae	Medium
5	Rye Grasse	*Lolium rigidum**	Poeceae	Very Low
6	Canary Grass	*Phalaris minor**	Poeceae	Very Low
7	Spring Wild Oat	*Avena fatua**	Poeceae	Very Low
8	Common Purslane	*Portulaca oleracea****	Portulacacea	Medium
9	Slender Amaranth	*Amaranthus viridis****	Amaranthacea	Medium
10	Bermuda Grass	*Cynodon dactylon*****	Poeceae	High
11	Barnyard Grass	*Echinochola crusgalli***	Poeceae	Low
12	Goose feet, Oak leaf	*Chenopodium glaucum***	Chenopodiaceae	Low
13	False daisy	*Eclipla prostrata***	Compositae	Low
14	Hooked bristle grass	*Setaria verticillata***	Poaceae	Low
15	Bull thistle	*Cirisium arvense***	Compositae	Low
16	Purple Nutsedge	*Cyperus rotendus*****	Poeceae	High
17	Italian rye grass	*Lolium multiflorum***	Poeceae	Low
18	Farsetia	*Farsetia aegyptia***	Brassicaceae	Low
19	Wild radish	*Raphanus spp**	Brassicaceae	Very Low
20	Asian mustard	*Brassica tournefortii***	Brassicaceae	Low
21	Indian melilot	*Melilotus indicus**	Leguminosae	Very Low
22	Black nightshade	*Solanum nigrum****	Solanaceae	Medium
23	Pig weed	*Amaranthus sylvestris****	Amaranthaceae	Medium
24	Digera	*Digera muricata**	Amaranthaceae	Very Low
25	Molita, Sow thistle	*Sonchus oleracous**	Compositae	Very Low
26	Creeping heliotrope	*Heliotropium supinum**	Chenopodiaceae	Very Low
27	Sprenage	*Flavera trinervia***	Compositae	Low

Y Braun, Blanquet Scale of Abundance or Prevalence; * = Very Low (20 %), ** =Low (40 %),*** = Medium (60 %), **** = High (80 %), and ***** = Very High (100 %) Prevalence.

provide more nutrient availability in the root zone, in comparison with relatively less frequent irrigations. These results are in agreements with results obtained by Armellina and Zimdahl 1989; and Mirabelli *et al*., 2005, who reported that, increasing irrigation levels and/or irrigation frequencies not only encouraged weed population intensities and dry matter accumulations, but also extended the period of emergence, promoted the regularity of developmental stages, and considerably hastened seed-weed dispersal in large number of weed species.

Water Use Efficiencies

Water use efficiencies, estimated either as weed population count or as unit dry weight per sub-sub-plot per cubic meter of water supplied are shown on table (5). Water use efficiency, based on weed count and number was considerably higher under relatively high water stress conditions, imposed by frequent irrigations every eight days, in comparison to irrigation every two days, in both seasons. In contrast, water use efficiency, estimated as unit dry weight per sub-sub-plot per cubic meter, of supplied water, was to a great extent lower under stress conditions, than that of high soil moisture contents imposed by high frequent irrigations, every two days. Orthogonal polynomial regression analyses (Table 5 and Fig. 1), broken into one degree of freedom with curve best fitting also described these behaviors resulting in quadratic and cubic responses, with highly estimated R^2 values. Obviously, under non-stress conditions, frequent irrigation every two days, where high soil moisture content and abundance of available irrigation water, there was high consumption of water usage, and each cubic meter of supplied water was able to produce only 49.0 and 37.1 weeds, in both seasons respectively. Whereas, under water stress condition, irrigation every eight days, each cubic meter of water consumed was capable of producing of 72.9 and 67.3 weeds, in the two seasons, respectively. Low water use efficiency, based on weed count and number, emerged under high frequent irrigations of two days, produced by each cubic meter of water consumed was, at the same time, high in water use efficiency, based on unit dry weight, in comparison with water use efficiencies under stressful conditions and irrigation every eight days. This behavior, perhaps, may be attributed to the optimum efficiency of each single exploited cubic meter of water consumed, under stressful conditions, in producing more weeds, through urgent flowering signal(s) and dispersing more seeds, under stress conditions, regardless of dry matter contents. On the other hand, each cubic meter of water consumed, under non-stress conditions, where abundance of irrigation water, was facilitating and providing more nutrients and photosynthates and assimilates for weeds to build up and accumulate dry matters, rather than getting involved in producing more weeds. However, these results are similar to results obtained by Jana *et al*., 1989; Saini and Chakor, 1994; and Domuta *et al*., 2006.

Weed Control Efficiency

Weed control efficiency, under the different irrigation frequency treatments (Table 5), exhibited highly significant and significant responses, in both seasons, respectively. Data clearly shown that, weed control efficiency was higher under high frequent irrigations, every two days, than those of the other irrigation frequency treatments. It seems obvious that there was a perceptible trend or tendency of plodding reduction in the efficiencies coincide with increasing watering intervals or reducing frequencies, in both seasons. This performance was well expressed by the highly significant linear response of the orthogonal polynomial regression analysis, broken down into one single degree of freedom and curve fitting (Fig. 1). This response might be due to efficient weed control mechanisms, under high soil moisture content; easy and effective manual hand weeding & pulling, as well as effective functioning and efficiencies of the different herbicides, under such circumstances.

Impacts of Manual Hand Weeding

Weed Population Density, Fresh and Dry Weights

The performances of weed population density, fresh and dry weights, as influenced by manual hand weeding treatments; every 4, 8, and 12 weeks and an unweeded control, are depicted on Table (5). Clearly, data obtained revealed strong impacts of manual hand weeding on weed population and growth performances, in both seasons. It is obvious that, frequent manual hand weeding every 4 weeks, immensely reduced weed population intensity as well as its fresh and dry weights, in comparison to the unweeded control, or even other hand weeding treatments. Frequent hand weeding every 8 weeks also exhibited noticeable reduction in weed count, fresh and dry weights, when compared either to the unweeded control or other weeding treatments. However, hand weeding every 12 weeks was also effective, although no significant differences were noticed between this treatment and the unweeded controls, in some cases. Orthogonal polynomial regression analyses, broken down into one single degree of freedom, with best curve fitting (Fig. 2) well described these quadratic performances, with high R^2 values. Many researchers and investigators

working with bulbous ornamentals also reported that frequent hand weeding immensely reduced weed total population, intensity and weed dry weights, in field grown tuberoses (Mohanty *et al*, 2002; and Panwar *et al*, 2005); gladioli (Chahal *et al*, 1994; Widaryanto *et al*, 1997; and Cheong *et al*, 2000); German Iris (Pennucci, 2000); Crocus (Bullitta *et al*., 1996); Elephant Foot Yam (Bhaumik *et al*, 1988; and Santosa *et al*, 2006); as well as non flowering bulbs, such as Potatoes (Singh *et al*, 2002; and Mirabelli *et al*., 2005).

Water Use Efficiencies

Water use efficiencies, estimated as number of weeds emerged or unit dry weight produced by sub-sub-plots per cubic meter of water consumed, for weeds emerged in field grown tuberoses, revealed highly significant impacts, as influenced by manual hand weeding, in the two growing seasons (Table 5). Each cubic meter of water consumed for irrigating unweeded sub-sub-plots was able efficiently to produce the highest number of weeds and the highest weed biomass. Manual hand weeding, particularly, frequent manual weeding every 4 weeks, however, immensely restricted and minimized this ability, reducing weed numbers and unit dry weights to the lowest values. Frequent weeding every 8 and/or 12 weeks manual hand weeding were also efficient in reducing weed count and dry weight produced by sub-sub-plots per cubic meter of water. Orthogonal polynomial regression analyses, broken down into one single degree of freedom, with best curve fitting, demonstrated in Table (5), and illustrated in Figure (2), clearly reflected these behaviors, supporting the anticipated results. Interference of manual hand weeding, limiting and restricting growth of weeds, result evidently in considerable weed competition reduction, in field-grown tuberoses. This eventually would be reflected on increases on tuberose productivities. Berger *et al*., 2007, reported 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.

Weed Control Efficiency

Weed control efficiencies (%), calculated as angularly transformed data, for the two growing seasons, were represented in Table (5). Manual hand weeding approach, for controlling weeds, in field-grown tuberoses, displayed noteworthy effects on emerging weeds. Hand weeding every 4, 8, and even 12 weeks efficiently controlled weeds, in comparison to the unweeded control. However, the highest weed control efficiency was due to frequent hand weeding every 4 weeks, followed by 8 and 12 weeks weeding, in sequence. Illustration of these performances is shown on Figure (2) demonstrating orthogonal polynomial regression analyses statistical results, expressing evidently quadratic responses, sustaining these results. Vidyadhar *et al.*, 1998, reported that, hoeing twice + hand weeding twice at 30 and 45 DAS, recorded higher WCE (86.30 %) and lower NPK uptake by weeds compared to hoeing once + hand weeding once at 30 DAS (69.02 %). Manorama, (2004) also found that, manual hand weeding twice (30 and 45 DAP) was very effective in increasing weed control efficiency (79.10 %).

Impacts of Herbicidal Treatments

Weed Population Density, Fresh and Dry Weights

Weed population intensity, weed fresh and dry weights parameters, as influenced by the pre emergence herbicide Pendimethalin, the post emergence herbicide glyphosate and a combination of both herbicides, as well as untreated control, are presented on Table (5). The different herbicide treatments revealed highly significant strong effects on weed parameters, according to the analyses of variance and F test of significance. Unstructured selective orthogonal contrasts, with single degree of freedom also exhibited noticeable highly significant and strong effects, for these parameters. Plots treated by Pendimethalin plus glyphosate immensely reduced weed density count as well as fresh and dry weights, in both seasons, in comparison to the untreated control or even to Pendimethalin alone or glyphosate treated plots. However, plots treated by the preemergence herbicide or the post emergence one also revealed highly significant reduction, in comparison with the untreated control, in the two growing seasons. Weed population density and growth performances, as influenced by the different herbicide treatments are well described also in Figure (3). Nevertheless, the immense reduction in weed population parameters induced by Pendimethalin as a preemergence herbicide plus the postemergence glyphosate, may be attributed to the strong synergistic effects of both herbicides, as indicated by the non-structured orthogonal contrasts. Evidently, the weed killer glyphosate, as an effective postemergence herbicide, caught whatever escaped from Pendimethalin as preemergence herbicide. Pendimethalin was

documented, through the literature, to function through inhibiting mitosis. Pendimethalin herbicidal effects and mode of action are related to the inhibition of cell division and cell elongation via preventing tubulin from polymerizing into microtubules, resulting in inhibiting mitosis (Hatzinikolaou *et al*, 2004). However, Glyphosate, mode of action, functions through inhibiting protein biosynthesis, via blocking the activity of a specific enzyme used by plants to make certain important amino acids. Without these amino acids, however, the plant cannot synthesizes proteins required for various life processes, resulting in the death of a plant (Eason *et al.,* 2000; and Cox, 2004. Pendimethalin application at rates ranging from 0.50 to 4.50 kg a. i/ha, resulted in excellent weed control of broad leaves and grassy weeds, and greatly reduced weed population, intensity and dry weights, in many ornamental flowering bulbs and herbaceous perennials, including tuberose (Murthy and Gowda, 1993); Gladiolus (Kwon *et al*., 1996; Misra, 1997; Sunil-Kumar *et al*., 2001; Arora *et al*., 2002; and Richardson and Zandstra, 2006); Tulip (Al-Khatib, 1996); Iris (Ivanova, 1999); and numerous herbaceous perennials (Calkins *et al.*, 1996). Panwar *et al*., 2005, also found that glyphosate at a rate of 2.0 a. i. % efficiently minimized weed intensity and population and greatly reduced weed dry weights, in field grown tuberoses. It also lowered weed count, dry weights and increased weed control efficiency in field grown gladiolus, according to Chahal *et al*., 1994; and Manuja *et al*., 2005. In a histological study conducted by Canal *et al*., 1989, on *Cyperus esculentus*, leaves and basal bulbs or rhizomes, they found that, the most remarkable effect of glyphosate was the appearance of one layer of sclerenchymatic cells between root and rhizome primordia and the cortical tissues, which, perhaps, could play an important role in the inhibition of rhizome and root emergence by the herbicide. Moreover, Seifert and Hott (1985) found that, 1.1 lb glyphosate + 2.0 lb Pendimethalin / acre, gave more than 90 % weed control, 45 days after treatment.

Water Use Efficiencies

Water use efficiencies, calculated for both weed population count and unit dry weight per sub-sub-plot per cubic meter of water, in both seasons, are shown on Table (5) and demonstrated in Figure (3). Water use efficiencies were greatly reduced by the presence of Pendimethalin and glyphosate together, minimizing weed count produced as well as its associated dry weights, in both seasons, in comparison to the untreated control. Great reductions were also found due to Pendimethalin or glyphosate alone, when compared with the untreated control. Strong synergistic impacts on water use efficiencies were due to the combined effects of the preemergence and postemergence herbicides, together. Minimum weed count produced as well weed dry weights due to the different herbicidal treatments, would evidently reduce or shorten water use by the controlled weeds, and eventually spare and increase water use efficiency, in the anticipated sub-sub-plots (crop), in field grown tuberoses. These results are in great agreements with results obtained by Tanji and Karrou (1992); and Anureet and Singh (2005).

Weed Control Efficiency

Data of weed control efficiencies, as percentages, presented in Table 5, and Illustrated in Figure 3, revealed very strong impacts, for Pendimethalin plus glyphosate together, resulting in the highest weed control efficiencies, in both seasons, in comparison to the untreated control or either the herbicide alone. Both herbicides also exhibited considerable weed control efficiencies, in comparison to the untreated control, or even to each other. It is worth notable that glyphosate was more efficient than Pendimethalin, in field grown tuberoses, in controlling weeds. These results are similar to results obtained by Panwar *et al*., 2005, on tuberose; and Chahal *et al*., 1994; and Manuja *et al*., 2005, on Gladioli.

Tuberose Cut Flower Yield

Tuberose cut flower yield was immensely affected by the three major factors; irrigation frequencies, manual hand weeding and herbicides, in the two growing seasons (Fig. 4).

Impact of Irrigation Frequencies

Frequent irrigations considerably improved tuberose cut flower yield, in both seasons. Irrigation every 2 days, under the western region arid zone, produced the highest cut flower yield per sub-sub-plot, in comparison to other irrigation frequency treatments. Statistical analysis also revealed highly significant differences among other irrigation frequency treatments, in both seasons. Irrigation every 2 days recorded 152.69, 192.36 and 301.57 % increases, in cut flower yield production per sub-sub-plot, over irrigation every 4, 6 and 8 days, respectively, in the first growing season. However, in the second growing season, the percent increases were 130.03, 177.45 and 284.42 %, respectively. The role of water in enhancing plant growth and productivity is well documented over the seasons. Several irrigation frequency and watering regime studies revealed very beneficial effects of irrigation and watering to numerous bulbous ornamentals (Papaneck, 1992, on Tulip; El-Naggar and Nassar, 1994, on Narcissus; Dandria *et al.*, 1996, on Gladioli; and Halepyati *et al.*, 2002, on Tuberose).

Impact of Manual Hand Weeding

Manual hand weeding greatly influenced tuberose cut flower yield, resulting in highly significant differences, in both seasons (Fig. 4). Frequent hand weeding every 4 weeks produced the highest yield of cut flowers, in comparison with either the unweeded control or those weeded every 8 or 12 weeks. However, there were also significant differences detected between 8 and 12 week weeding treatments, in both seasons. Manual hand weeding every 4, 8 and 12 weeks registered 153.99, 138.48 and 113.04 % increases in tuberose cut flower yields, respectively, in the first growing season. However, in the second growing season, there were 186.36, 149.68 and 132.78 % increases, respectively in comparison with the unweeded controls. These performances may perhaps be attributed to the strong influences of manual hand weeding in removing and eliminating weeds, reducing weed competitions for nutrients and available water soil moisture content, space and solar energy, which subsequently might have been reflected on tuberose cut flower yield enhancement. Many researchers also reported that, frequent hand weeding immensely reduced weed total population, intensity and weed dry weights, and greatly improved the major crop production, in field grown tuberoses (Mohanty *et al*, 2002; and Panwar *et al*, 2005); Gladioli (Chahal *et al*, 1994; Widaryanto *et al*, 1997; and Cheong *et al*, 2000); German Iris (Pennucci, 2000); and Crocus (Bullitta *et al*., 1996); Santosa *et al*, 2006).

Impact of Herbicides

The different herbicidal treatments profoundly affected tuberose cut flower yield in the two growing seasons. Figure 4 illustrate the performance of tuberose yield of cut flowers as influenced by pendimethalin, glyphosate and pendimethalin plus glyphosate versus the untreated control, in both seasons. Tuberose cut flower yield was remarkably increased due to the existence of pendimethalin, as preemergence, and glyphosate, as postemergence herbicides, in one single treatment, in comparison with the untreated control or either herbicide applied separately. Nevertheless, pendimethalin application alone or glyphosate were also effective in ameliorating tuberose cut flower yield, when compared to the untreated control, in both seasons. The application of pendimethalin, glyphosate and pendimethalin + glyphosate recorded 127.32, 158.87 and 223.51 % increments in tuberose yield, respectively, in the first season, whereas it recorded 136.93, 155.46 and 212.72 % increases, respectively, in the second growing season. These noticeable performances might be accredited to strong and powerful effects of the preemergence and postemergence herbicides and their favorable synergistic effects when they existed together, in reducing weed population intensity, fresh and dry weights, weed water use efficiencies and the increased weed control efficiency minimizing, subsequently, weed competitions. This perhaps might be responsible for tuberose cut flower yield improvements. Numerous researches reported that, pendimethalin application at rates ranging from 0.50 to 4.50 kg a. i/ha, resulted in excellent weed control of broad leaves and grassy weeds, and greatly reduced weed population, intensity and dry weights, in many ornamental flowering bulbs and herbaceous perennials, including tuberose (Murthy and Gowda, 1993); Gladiolus (Kwon *et al*., 1996; Misra, 1997; Sunil-Kumar *et al*., 2001; Arora *et al*., 2002; and Richardson and Zandstra, 2006); Tulip (Al-Khatib, 1996); Iris (Ivanova, 1999); and numerous herbaceous perennials (Calkins *et al.*, 1996). Panwar *et al*., 2005, also found that glyphosate at a rate of 2.0 a. i. % efficiently minimized weed intensity and population and greatly reduced weed dry weights, in field grown tuberoses, in Haryana-India. It also lowered weed count, dry weights and increased weed control efficiency in field grown gladiolus, according to Chahal *et al*., 1994; and Manuja *et al*., 2005. Moreover, Seifert and Hott (1985) found that, 1.1 lb glyphosate + 2.0 lb Pendimethalin / acre, gave more than 90 % weed control, 45 days after treatment.

Pearson Correlation Analyses

Pearson correlation analyses (Table 6) demonstrate the different correlation coefficients of the different weed parameters, traits and tuberose cut flower yield, in the two growing seasons. It describes the nature and behavior of tuberose yield in relation to weed population density and growth performances. Tuberose cut flower yield was negatively correlated with weed population density only in the second growing season. However, the first growing season was not significant. This indicate negative reciprocal relationship between tuberose yield and the number of weed emerged (as the number of weed emerged decreases tuberose yield increases accordingly). Strong highly significant negative correlations were also detected between tuberose cut flower yield and water use efficiencies (estimated as number or unit dry weight / m^2 / m^3 of water), in both seasons. This implies that as weed water use efficiencies decreased, cut flower yield of tuberose would increases subsequently. Moreover, highly significant positive relationships were also detected between flower yield and weed control efficiency in both seasons, indicating that, tuberose cut flower yield would increases

simultaneously as the efficiency of weed control increases.

Conclusion & Recommendations

Conclusion and recommendations emerging after this investigation can be summarized in the following points:

1- Weed competition is a biological interaction between weeds and tuberose plants for limited resources, mainly light & solar energy, water, nutrients and space, resulting in reducing tuberose yield and quality, and should be eliminated and controlled by all means.

2- Frequent watering and irrigation is indispensable for tuberose plants, and weed control management must be performed, for higher yield and quality for tuberose plants.

3- Although manual hand weeding is very effective in controlling weeds, but it is laborious, costly, expensive and somehow inconvenient under the Saudi Arabian, Western Region harsh environmental conditions.

4- The use of herbicides was proven very effective, in controlling weeds, in field-grown tuberose, accordingly, weed control under such circumstances require compromising decision.

5- Combination of preemergence (Pendimethalin) and postemergence (glyphosate) herbicides, was found very effective, in controlling weeds, which is consequently very beneficial to tuberose plants.

6- Further investigation should be performed on the economy and cost/benefit ratio of irrigation frequency, hand weeding and the use of herbicides, in controlling weeds, in field grown tuberoses and feasibility of tuberose production, under such circumstances.

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References

Abdul Ghaffoor, 2004. Integrated weed management in different varieties of onion (*Allium cepa, L.*). Pak. Jour. Weed Sci. Res. Vol. 10 (1/2): 55-62.

AL-Dubaikhi, B. A. 1999. Numerical for evaluation of the ground water reservoir in the agricultural experimental station in Hada Al-Sham. M. Sc. Thesis, Fac. Meteo. Environ. & Arid Land Agric. Kaau, Jeddah-K.S.A.

Al-Khatib, K. 1996. Tulip (*Tulipa spp*) and Iris Response to

Preemergence Herbicides. Weed Tech. Vol. 10 (4): 710-715.

Al-Turki, T. A.; and Abdul Ghafoor. 1996. The Genus *Chenopodium L.* in Saudi Arabia. Feddes Repetorium. Vol. 107 (3/4): 189-208.

Anureet, K.; and V. P. Singh. 2005. Moisture extraction pattern, consumptive use of water and water use efficiency of hybrid pearl millet as influenced by planting methods, mulching and weed control under rainfed conditions. Res. on Crops. Vol. 6 (2): 199-201.

Armellina, D. A. A.; and R. L. Zimdahl. 1989. Effect of watering frequency, drought and glyphosate on growth of field bindweed (*Convolvulus arvensis*). Weed Sci. Vol. 37 (3): 314-318.

Armitage, A M.; and J. M. Laushman. 1990. Planting date and in-ground time affect cut flowers of *Liatris, Polianthes* and *Iris*. HortScience. Vol. 25 (10): 1239-1241.

Arora, J. S.; Singh, K.; and H. C. Kundra. 2002. Effect of preemergence Herbicides in *Gladiolus* Planting. Flori. Res. Trend India. Proc. Nal. Symp. Indian Flori. In the New Millinn. Lal-Bagh. Bangalore, 25-27, Feb.: 122-125 (C.F. CAB Abst. An: 3170058).

Balah, M. A: Zidan, Z. H.; Dahroug, A. S.; and A. G. Abdel-Rahman. 2006. Response of *Cyperus rotendus* weeds to glyphosate herbicide with some adjutants under greenhouse conditions. Jour. Agric. Sci. Mansoura Univ. Vol. 31 (3): 1653-1667.

Berger, A.; McDonald, A.; and S. Riha. 2007. The Role of weed competition in crop water use efficiency. ASA-CSSA-SSSA, International Annual Meetings, Nov. 4-8. New Orleans, Louisiana-USA.

Bhaumik, S. K.; Sen, H.; and S. P. Bhattadrarya. 1988. Effect of herbicides and planting methods on the yield of elephant foot yam (*Amorphophallus campanulatus*, Blume). Jour. Root Crops. Vol. 14 (1): 23-26.

Braun-blanquet, J. Pflanzensoziologie. Wien, 1964. (C. F. Zareh, M. M., and K. A. Fargali. 1991. Vegetation of inland desert wadies in Egypt. Feddes repertorium. Vol. 102 (7/8): 647 – 656.

Bullitta, P.; Milia, M.; Pinna, M. E.; Satta, M.; and G. M. Scarpa. 1996. Initial results of the effects of different agronomic treatments on *Crocus sativus,* L. in Sardinia. Rivista Italiana, EPPOS. Vol. 19: 131-137 (C.F. CAB Abst., An: 311819).

Calkins, J. B.; Swanson, B. T.; and D. L. Newman. 1996. Weed Control Strategies for field grown herbaceous perennials. Jour. Environ. Hort. Vol. 14 (4): 221-227.

Canal, M. J.; Albuerne, M.; Sanchez, T. R.; and B. Fernandez. 1989. Glyphosate injury on *Cyprus esculentus* leaves and basal bulbs: Histological Study. Weed Res. Oxford. Vol. 30 (2): 117-122.

Chahal, D. S.; Sehgal, O. P.; and K. K. Singh. 1994. Effect of chemical and agronomic treatments on population and growth of weeds in *Gladiolus* Field. Annals of Biol. Vol. 10 (2): 245-249.

Cheong, D. C.; Kim, J. M.; and H. B. Park. 2000. Effects of weeding time on growth and flowering of *Gladiolus* 'Spic and Span'. Jour. Korean Soc. Hort. Sci. Vol. 41 (2): 201-206.

Cox, C. 2004. Herbicide fact sheet; Glyphosate. Jour. Pesticide Reform. Vol. 24 (4):10-15.

Dandria, R.; Mori, M.; and G. Morelli. 1996. Effects of water regime on yield and water use efficiency in two gladiolus cultivars. Irrigazione e Drenaggio. Vol. 43 (3): 22-27. (C. F. CAB Abst. AN. 970301480).

Derr, J. F. 2004. The Status of weed science at universities and experiment stations in the northeastern united states. Weed Tech. Vol. 18:1150-1156.

Domuta, C.; Borza, I.; Bandici< G.; Sabau, N. C.; Sandor< M.; Samuel, A. Bucurean, E.; Stanciu, A.; Ardelean, I.; Carbunar, M.; and C. Domuta. 2006. Influence of the crop rotation, soil tillage, water supply and weeds on water use efficiency in maize. crop0 from cris plain. (C. F. CAB Abstr. An: 20073020261).

Eason, J. R.; Johonson, J. W.; and De-Vre, L. 2000. Reversal of glyphosate inhibition of *Sandersonia aurantiaca* flower senescence with aromatic amino acids. Post harvest Biol. & Tech: 81-84.

El-Naggar, A. I.; and I. N. Nassar. 1994. Performance of *Narcissus tazetta, L,.* as influenced by Soil Water Matric Potential (SWMP) under different soil textures. Assiut J. Agric. Sci. 25 (1): 149- 170.

El-Naggar, A. I.; and S. H. Byari. 1999 a. Improving the performance of tuberose plants, as a new floricultural crop, in the western region of saudi arabia. i. vegetative growth, cut flower yield, flowering characteristics, and flower quality as functions of some horticultural agrotechniques. Egypt. Jour. Appl. Sci. Vol. 14 (10): 229-257.

El-Naggar, A. I.; and S. H. Byari. 1999 b. Improving the performance of tuberose plants, as a new floricultural crop, in the western region of saudi arabia ii. bulb yield, clump growth parameters, and bulblet formation as functions of some horticultural agrotechniques. Egypt. Jour. Appl. Sci. Vol. 14 (10): 258--283.

EL-Naggar, A. I. and S. H. Byari 1999 c. Ameliorating the performance of tuberose plants, as a new floricultural crop, in the western region of saudi arabia: a. influences of dates of planting, npk fertilization rates and application frequencies on vegetative growth, cut flower yield, flowering characteristics and flower qualities. Annals of Agric. Sci. Moshtohor. Vol. 37 (3): 1869-1891.

EL-Naggar, A. I. and S. H. Byari 1999 d. Ameliorating the performance of tuberose plants, as a new floricultural crop, in the western region of saudi arabia: b. influences of dates of planting, npk fertilization rates and application frequencies on bulb yield, bulb growth and development and bulblet formation. Annals of Agric. Sci. Moshtohor. Vol. 37 (3): 1893-1914.

Freed, R. S.; Eisen Smith, P.; Goptz, S.; Reicosky, D.; Smail, V. W.; and P. Wolberg. 1985. "MSTAT 4.0", A software program for design, management and analysis of agricultural research experiments. Pub. By Michigan State University, USA.

Gomez, K. A.; and A. A. Gomez. 1984. Statistical Procedure for agricultural research. 2nd Ed. John Wiley & Sons, Inc. New York, Chichester, Brisbane, Toronto, Singapore. An Int. Rice Res. Inst. Book.

Guralnik, D. B. 1978. Webster's New World Dictionary of the American Language, Seond College Edition. William Collins & World Pub. Co. Inc.

Halepyati, A. S.; K. Sujatha; and M. Prabhakar. 2002. Growth, yield, and water use of summer tuberose as influenced by irrigation regime and plant densities. Jour. Ornamental Hort. (New Series). Vol. 5 (1): 47-50.

Hatzinikolaou, A. S.; I. G. Eleftherohorinos. and I. B. Vasilakoglou. 2004. Influence of formulation on the activity and persistence of pendimethalin. Weed Tech. Vol. 18: 397-403.

Hussein, M. T.; and A. S. Bazuhair. 1992. Ground Water in Hada Al-Sham Al-Bayada Area, Western Saudi Arabia. Fac. of Earth Sciences Rept., King Abdul-Aziz University. P.O. Box 1744- Jeddah 21441. Saudi Arabia.

Ivanova, I. 1999. Investigation on preemergence herbicides against annual weeds in stands of bulbous *Iris*. Rasteniev. Dni-Nauki. Vol. 35 (2): 124-127. (C.F. CAB. Abst. An: 2300726).

Jackson, M. L. 1973. Soil and Chemical Analysis. Prentice Hall, Inc. New-Delki-India.

Jana, P. K.; Sounda, G.; Mukherjee, A.K.; Ahasan, A. K. M. M.; Ghatak, S.; and A. Barik. 1989. Effect of irrigation and weed control on growth, yield, consumptive use efficiency of summer groundnut. Indian Agriculturist . Vol. 33 (2): 87-94.

Kidd, H.; and D. R. James. 1991. The Agrochemicals Handbook, 3 rd Ed., Royal Soc. Chem. Info. Serv., Cambridge, UK.

Kwon, O. D.; Kim, H. J.; Kim, J. K.; and K. P. Han. 1996. Herbicide evaluation for preemergence weed control under various cropping patterns in *Gladiolus*. RDA Jour. Agric. Sci. Crop Protection. Vol. 38 (1): 495-500.

Manorama, K. 2004. Weed management in potato in Nilgiris. Potato Jour. Vol. 31 (1/2): 91-93.

Manuja, S.; Raja, R.; Singh, R. D.; and D. Mukherjee. 2005. Evaluation of different herbicides for protection of Gladiolus (*Gladiolus spp.*) crop from weeds. Crop Protection. Vol. 24: 921-926.

Mehmood, T. Khokhar, K. M.; and M. Shakeel. 2007. Integrated weed management practices in garlic crop in Pakistan. Crop Protection. Vol. 26: 1031-1035.

Miller, R. L.; Lockerman, R. H.; and C. R. Hunt. 1981. Glyphosate application. Proc. of the Western Soc. Weed Sci. Vol. 34: 95.

Mirabelli, C.; Cola, G.; Fiorillo, A.; Cardarelli, M.; Rouphael, Y.; and R. Paolini. 2005. The effect of mechanical weed control technique and irrigation method on yield, tuber quality and weed suppression in organic potato. Acta Hort. 684:127-133.

Misra, R. L. 1997. Stomp (Pendimethalin)- an effective weedicide in *Gladiolus* plantings. Progressive Hort. Vol. 29 (1/2): 74-76.

Mohanty, C. R.; Mishra, M.; and A. Mohapatra. 2002. Effect of nitrogen and weeding on tuberose. Flori. Res. Trend. India. Proc. Nal. Symp. Indian Flori. In the New Mellinn. 25-27 Feb.: 340-342. (C. F. CAB Abst., An: 3176764).

Murthy, G. M. A.; and J. V. N. Gowda. 1993. Evaluation of herbicides for weed control in tuberose (*Polianthes tuberosa, L.*) cv., "Double". Crop Research. Vol. 6 (1): 176-178.

Panwar, R. D.; Sindhu, S. S.; Balyan, R. S.; and J. R. Sharma. 2005. Studies on weed control in tuberose cv. 'single' by pre and post-emergence herbicides. Haryana Jour. Hort. Sci. Vol. 34 (1/2): 87-89.

Papanek, D. 1992. Rational irrigation of tulip bulbs. Zahradnictvi. Vol. 19 (3): 203-210 (C.F. CAB Abst. AN. 930322287).

Pennucci, A. 2000. Influence of weed growth and herbicides on disease development and rhizome injury to German *Iris*. Proc. Fifty-Fourth Annual Meeting of the Northeastern Weed Sci. Soc. Baltimore, M. D. USA, 3-6 Jan.: 146-149.

Richardson, R. J.; and B. H. Zandstra. 2006. Evaluation of Flumioxazin and other herbicides for weed control in gladiolus. Weed Tech. Vol. 20 (2): 394-398.

Rooy, M. D.; and A. T. J. Koster. 1978. Control of perennial weeds in 2-year crops of narcissi. Bloembollenculture. Vol. 89 (8): 175 (C.F. CAB Abst., An: 369262).

Saini, J. P.; and I. S. Chakor. 1994. Effect of soil moisture regimes and weed control treatments on water use, Water Use Efficiency (WUE) and yield of sugarcane in Himachal Pradesh. Indian Sugar. Vol. 44 (8): 639-642.

Santosa, E.; Sugiyama, N.; Nakata, M.; Mine, Y.; Lee, O. N.; and D. Sopandie. 2006. Effect of weeding frequency on the growth and yield of elephant foot yams in agro forestry systems. Japanese Jour. Trop. Agric. Vol. 50 (1): 7-14.

SAS. 1978. STAT User's Guide: Statistics, SAS Inst. Inc. SAS-Circle. P. O. Box 8000, Cary, NC 27512-USA.

Seifert, J. R.; and H. A. Hott. 1985. Herbicide test on white ash, tulip poplar, and red oak. Proc. North Central Weed Control Conference. Vol. 40: 31.

Singh, K. P. 1995 . Improved production technologies for tuberose (*Polianthes tuberosa, L.*) – A review of research done in India. Agric. Rev., Vol. 16 (3): 141-166.

Steel, R. C.; and J. H. Torrey. 1980. Principles and procedures of statistics. Mc-Grow Hill Book Co., Inc., New York, London.

Sunil-Kumar; Gupta, A. K.; and J. N. Singh. 2001. Effect of herbicides on weed control in *Gladiolus grandiflorus, L. cv*., Friendship. Haryana Jour. Hort. Sci. Vol. 30 (1/2): 50-51.

Tag-El-Din, A. T. F.; Soliman, F. S.; and A. Al-Harbi. 1997. Effects of chemical weed control on root yield and quality of carrots (*Daucus carota, L.*). Jour. King Saudi Univ. Agric. Sci. Vol. 9: 163-175.

Tanji, A.; and M. Karrou. 1992. Water use and water use efficiency of weeds and wheat in Semi-arid Morocco. AL-

Awaqmia (78): 29-43 (C. F. CAB Abst. An: 19950702303).

Trueblood, E. W. E. 1973. "Omixochitl" -The Tuberose (*Polianthes tuberosa*, *L*.). Economic Bot. Vol. 27 (2): 157-173.

Vidyadhar, K.; Meli, S. S.; Salakina-Koppa, S. R.; Pattar, P. S.; and T. S. Rudreshappa. 1998. Tuber yield and nutrient removal by crop and weeds as influenced by weed control methods in kharif potato (*Solanum tuberosum*, L.). World Weeds. Vol. 5 (1/2): 61-65.

Widaryanto, E.; L. Soetopo and R. D. Andajani. 1997. Influence of weed control system on the growth and production of gladioli flowers (*Gladiolus hybridus*, *L*.). Agrivita, Vol. 18 (1): 14-20. (C. F. CAB Abst., An: 2300621).

WSSA, 1989. erbicide Handbook of the Weed Science Society of America, 6 *th* Ed. WSSA, Champaign, IL., USA.

Zimdahl, R. L. 2004. Weed-Crop Competition: A Review, 2nd Ed., Blackwell Pub. Co. 2121 State Ave. Ames, IA., 50014. USA., 220 p.

مقاومة الحشائش في الحقول المنزرعة بالصنف المجوز من نباتات التيوبروز تحت ظروف الأراضي الجافة بالمنطقة الغربية للمملكة العربية السعودية : أ. كثافة الحشائش ، سلوكيات النمو و المحصول الزهري للتيوبروز كدالة لتكرارت الرى ، المقاومة اليدوية و مبيدات الحشائش

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تمثل الحشائش تحديا كبيرا في حقول التيوبروز وخاصة تحت نظام الرى بالغمر في المنطقة الغربية بالمملكة العربية السعودية مما يمثل عائقا كبيرا في تطوير وتحسين انتاجية زهور القطف والأبصال ، مما أدى إلى إجراء دراسة استقصائية لمجابهة هذة المشكلة. أجريت تجربة حقلية بمحطة البحوث الزراعية والتابعة لجامعة الملك عبد العزيز بوادي هدى الشام بمنطقة مكة المكرمة ، خلال عامي 2001/ 2002 و 2002/ 2003، بهدف دراسة تأثير تكرار الرى (رى كل يومين ، أربعة ، ستة وكل ثماني أيام) ، المقاومة اليدوية للحشائش (الكنترول أو المقارنة ، مقاومة يدوية كل أربعة أسابيع، كل ثماني أسابيع، وكل إثنى عشر أسبوعا ، و مقاومة الحشائش باستخدام المبيدات (الكنترول (بدون استخدام أية مبيدات حشائش) ، بنديميثالين ، جلايفوسات ، و بنديميثالين + جلايفوسات) وذلك على كثافة الحشائش ونموها وسلوكياتها في حقول التيوبروز "الصنف المجوز" .

صممت التجربة بنظام الوحدات الشقية-الشقية (المنشقة مرتين) في تصميم القطاعات كاملة العشوائية ذات أربعة مكررات وقد مثلت معاملات تكرار الرى القطع الشقية الكبرى ، معاملات مقاومة الحشائش يدويا فقد مثلت بالقطع التحت شقية. أما معاملات مقاومة الحشائش باستخدام المبيدات فقد مثلت بالقطع الشقية الصغرى (القطع التحت تحت شقية).

كانت أهم نتائج هذه الدراسة كالتالي:

- بينت هذه الدراسة الأستقصائية أن النجيل البلدي والسعد كان أكثر الحشائش انتشارا، بينما كانت حشائش العليق ، الخبيزة الشيطاني ، الرجلة ، الزربيح وعنب الديب متوسطة في انتشارها. اما عين القط ، المنتنة ، الرمرام ، الدنيبة ، الإيكليبلا ، الدفرة ، الكيريزيم ، الهيبان ، الجرباء ، الكبر البلدي والفلافيرا فقد كانت أقلهم انتشارا.

- كان لكثرة تكرار عدد مرات الرى كل يومين وزيادة المحتوى الرطوبي بالتربة أثرا معنويا قويا في زيادة كثافة الحشائش عدديا وفي زيادة وزنها الغض والجاف وكفاءة المياه المستخدمة بالنسبة لوحدة الوزن الجاف وأيضا زيادة معامل كفاءة مقاومة الخشائش تحت هذه الظروف وذلك بالمقارنة بظروف الجفاف النسبي والرى على فترات طويلة نسبيا كل ثمانية أيام.

- أدت المقاومة اليدوية للحشائش كل أربعة أو ثماني أسابيع إلى أنخفاض معنوي وواضح في أعداد الحشائش النامية وكذلك وزنها الغض والجاف وكذلك كفاءة استخدام مياه الرى مما أدى إلى زيادة معنوية وملحوظة في زيادة النسبة المئوية لكفاءة مقاومة الحشائش ، وذلك بالمقارنة بمعاملة الكنترول ، في كلا الموسمين.

- أدت كل معاملات مبيدات الحشائش إلى حدوث تأثير قوي وملحوظ في انخفاض أعداد الحشائش النامية بشدة وكذلك صفاتها المرتبطة بالمقارنة بالكنترول. ومن الجدير بالذكر أنه كان لتواجد البنديميثالين كمبيد ماقبل ظهور الحشائش والجليفوسات كمبيد مابعد ظهور الحشائش معا في معاملة واحدة تأثيرا قويا ايجابيا متلازما ومشجعا تبادليا في انخفاض أعداد الحشائش وأوزانها الغضة والجافة وكذلك كفاءة استخدام مياه الرى مما أدى إلى زيادة ملحوظة في النسبة المئوية لكفاءة مقاومة الحشائش وذلك بالمقارنة بمعاملة الكنترول.

- أدت معاملات الرى المتكرر ألى زيادة معنوية وملحوظه للمحصول الزهري للتيوبروز وكان أعلاها عند الرى المتكرر كل يومين .

- أدت المقاومة اليدوية للحشائش كل أربعة أو ثماني أسابيع أو حتى كل 12 أسبوع إلى زيادة معنوية في محصول الشماريخ الزهرية بالمقارنة بالكنترول ، وكان أعلى محصول عند استعمال المقاومة اليدوية كل أربعة أسابيع.

- أدت كل معاملات مبيدات الحشائش إلى حدوث تأثير قوي وملحوظ في زيادة عدد الشماريخ الزهرية الناتجة بالمقارنة بالكنترول. ومن الجدير بالذكر أنه كان لتواجد البنديميثالين كمبيد ماقبل ظهور الحشائش والجليفوسات كمبيد مابعد ظهور الحشائش معا في معاملة واحدة تأثيرا قويا ايجابيا مشجعا في الحصول على أعلى محصول زهري للتيوبروز.

- كان هناك تلازم معنوي قوي وسالب بين المحصول الزهري للتيوبروز وكفاءة الحشائش لاستعمال مياه الرى ، وأيضا تلازم قوي وموجب مع كفاءة مقاومة الحشائش.