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Integrated weed management strategies on weed flora, vase life and economic parameters of Prajwal tuberose

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ABSTRACT

An experiment was carried out from April 2014 to March 16 to find out the impact of integrated weed management practices on tuberose cv. Prajwal, it is loose flower used for perfumery extraction, garland and semi-double, double type for cut flower crop, weed presence always compete for light, water, nutrient with main crop ultimately reduce yield and quality of floral and bulb, experiment was comprised with fourteen integrated treatments combination like three hand weeding at 30,60,90 days interval, three levels of four pre-emergence herbicides chemicals like pendemethalin (0.75, 1.0 kg a.i. ha^{-1}, 0.75 kg a.i. ha^{-1} + one hand weeding at 40 DAP), oxyflourfen(0.5, 0.75 kg a.i. ha^{-1}, 0.75 kg a.i. ha^{-1} + one hand weeding at 40 DAP), atrazine (1.0, 1.5 kg a.i. ha^{-1},1.0 kg a.i. ha^{-1} + one hand weeding at 40 DAP), butachlor (1.0, 1.5 kg a.i. ha^{-1},1.0 kg a.i. ha^{-1} + one hand weeding at 40 DAP) and weedy check replicated thrice in randomized block design. In the present investigation the pre emergence application of pendimethalin @ 1.0 kg a.i. / ha showed significantly lowest weed population (number / m^2), fresh weight and dry weight of weeds (g /m^2) with highest weed control efficiency (%) at 25 DAP respectively, integrated pre- emergence combination of pendimethalin @ 0.75 kg a.i / ha + one hand weeding application at 50 DAP and three hand weeding at 30, 60 and 90 days interval practice recorded at 75 DAP were at par and better over the weedy check. Whereas, three hand weeding at 30, 60 and 90 DAP were recorded highest vase life (days), water uptake (ml), loose flower yield (5285, 13847 kg ha^{-1}), bulb yield ha^{-1} (279459, 985800 ha^{-1}), gross returns and net returns (₹ / ha) in the year 2014 and 2015 respectively. However, pre-emergence application of pendimethalin @ 0.75 kg a.i. / ha + one hand weeding at 40 days was statistically at par with three hand weeding at 30, 60 and 90 DAP, which recorded highest BC ratio (1.56, 20.27 respectively) during 2014 and 2015. Therefore, on the basis of two years results it is recommended that combination of pre-emergence application of pendimethalin @ 0.75 kg active ingredient per ha + one hand weeding at 40 days proved beneficial for integrated weed management in tuberose.

Key words: *Polianthes tuberosa*, hand weeding, herbicide, vase life, water uptake, bulb yield.

INTRODUCTION

Tuberose (*Polianthes tuberosa* L.) is commonly known as 'Rajanigandha' belongs to family Amaryllidaceae and native to Mexico from where it was spread to different parts of the world. It is believed that tuberose was brought to India via Europe in 16th century. *Polianthes* genus contains four types of flowers one of them is single flower type had deploid chromosome number 2n = 60, used for loose flower, raw material in perfumery industry and in breeding programme as female parent, semi-double, double type of flower due to gene mutation had 2n = 50 , 54, 60, 120 are generally used for cut flower in vase (Karihaloo, 7) and variegated type.

It is commercially propagated by bulbs and generally, bulbs diameter ranges from 1.5 to 2.5 cm are suitable for planting. Tuberose is commercially cultivated on large scale in China,Egypt France, Hawai, Italy, Kenya, Mexico, Morocco, NorthCarolina, South Africa, Taiwan,USA, tropical and subtropical areas in India. It is commercial cultivated mainly in Mysore, Devanhalli taluk, Belgaum,Kolar,Tumkur (Karnataka), East Godavari, Guntur, Chitoor, Krishna District (Andhra Pradesh), Coimbatore and Madurai (Tamil Nadu), Ahemadnagar, Nasik, Pune, Thane, Sangli (Maharashtra),Bagnan, Kolaghat, Krishna Nagar, Midnapur, Panskura, Ranaghat (West Bengal), Udaipur, Ajmer, Kota and Jaipur(Rajasthan) in India reported by Safeena *et al.* (13). As par Department of Agriculture Cooperation and Farmers Welfare Govt Of India data base the area under Indian floriculture 3,03,000 ha with 2263 MT loose flower and 647 thousand MT cut flower production during 2018-19. Third advance estimate showed area covered by floriculture 3910 ha under loose flower crops and annual production 1288 MT in Rajasthan state during 2019-20 out of that (Anonymous, 1). This is fact that in tuberose cultivation one of the main constraints is weed. Weeds cause irreparable damage to crops by competing for water, nutrients, light, space and also acting as alternate hosts to a number of pathogens and insect pests. Manual weeding is

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time consuming, costly, scarcity of workers leads the way to think for its integrated approach to overcome weeds problem. Therefore, suitable strategy for integrated weed management is the prime need to reduce weed competition and to improve the quality of cut spike and loose flower production. Hence, combination of cultural and herbicide techniques are moderately cheapest, appropriate and effective for weed management. There is possibility to be application of herbicide with hand weeding which can be more effective and economically to reducing weed opposition at right time to obtain highest flower and bulb production in tuberose. Hence keeping in view the importance of weed management in tuberose present study was under taken

MATERIALS AND METHODS

The experiment was carried out for April 2014-15 and March 2015-16 to study the integrated weed management practices in tuberose cv. Prajwal at AICRP on Floriculture Project, Horticulture Farm, RCA Campus, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, which is situated at 24º35' N latitude, 73º42' E longitude and 579.5 metre above mean sea level altitude. Tuberose cultivar Prajwal was evolved by IIHR-Bengluru, which is hybrid from Shringar × Mexican Single, single type along with 90- 95 cm spike length , 52.0 floret / spikes,6.2 cm floret length, 4.3 cm floret diameter, sturdy spike with pinkish floral buds and white flower was selected. Fourteen treatments including namely, Pre emergence (PE) application of Pendimethalin@ 0.75 kg a.i. ha^{-1}, Pendimethalin @ 1.0 kg a.i. ha^{-1}, Pendimethalin @ 0.75 kg a.i. ha^{-1}+ one hand weeding at 40 DAP, Oxyfluorfen @ 0.50 kg a.i. ha^{-1}, Oxyfluorfen @ 0.75 kg a.i. ha^{-1}, Oxyfluorfen @ 0.50 kg a.i. ha^{-1} + one hand weeding at 40 DAP, Atrazine @ 1.0 kg a.i. ha^{-1}, Atrazine @ 1.5 kg a.i. ha^{-1}, Atrazine @ 1.0 kg a.i. ha^{-1} + one hand weeding at 40 DAP, Butachlor @ 1.0 kg a.i. ha^{-1}, Butachlor @ 1.5 kg a.i. ha^{-1}, Butachlor @ 1.0 kg a.i. ha^{-1} + one hand weeding at 40 DAP, three hand weeding at 30, 60 and 90 days interval and weedy check (control) in randomized block design, with three replication. The minimum temperature were ranges from 4.8 °C – 28.4°C , 4.0°C - 28.0 °C, maximum from 22.6°C – 42.4°C , 23.9°C -40.8 °C) and percent relative humidity were ranges from minimum (19.3-82.9, 11.7-88.9 %) to maximum (43.1-92.4, 28.9-92.1) during 2014 and 2015 respectively. Tuberose' bulbs were collected from AICRP on Floriculture Project, MPUAT, Udaipur. The required quantity of pre-emergence herbicides were dissolved in water and applied by flat fan nozzle foot sprayer on randomly selected treatments plot. All pre-emergence herbicides were sprayed once at 4 days before bulb planting and second year before sprouting of bulb at the time of dormancy period. Herbicide and integrated combination treatments were compared with three hand weeding where the weeds were removed manually and weedy check. Healthy and uniform sized bulbs have 1.5-2.5 cm diameter were planted in the third week of April 2014 with row × plant spacing at 30cm × 30cm at 5-6cm depth. Thirty bulbs for each treatment per replication were planted in each plot. The soil was clay loam in texture, with pH 7.34 and EC 0.54 dSm^{-1} under irrigated condition. Well-decomposed 2.5kg/m^2farm yard manure was incorporated into all the plots two weeks prior to planting. A basal fertilizer dose comprising 125 kg N_2, 200kg P_2O_5 and 200kg K_2O $ha^{-1}$was applied at planting time and remaining half dose of N 125 kg was applied 45 days after planting (Meena *et. al*, 10). Uniform cultural practices were followed throughout the experiment. The bulbs were lifted from the field when the foliage turned yellow shade drying of bulbs was followed by cleaning, counting and weighing of bulbs for recording of desired observations. Further, bulbs were stored after treatment with fungicide for succeeding crop. Data on weed flora (numbers / m^2,) fresh weight, dry weight (g/ m^2) vase life (days), water uptake(ml), loose flower (kg ha^{-1}) bulb yield (numbers) per hectare were recorded on five randomly selected plant s and mean data two year were statistically analyzed with procedure described by Panse and Sukhatme (11). The weed populations (number m^2) were recorded at 25, 50 and 75 DAP with the help of 50 cm × 50 cm quadrat, thrown randomly in the plots from two spots. All the weeds in 50 cm × 50 cm quadrat were cut from soil surface above ground and put into paper bags from every plot. The fresh and dry weight of weed m^2(g) were recorded with the help of Sartorius electronic balance. The weed samples were sundried for 20 days until they lost maximum moisture. Then samples were kept in oven for 48 h at 50°C and final dry weight was recorded. Weed control efficiency (WCE) was calculated with following formula.

$$\text{Weed Control Efficiency (\%)} = \frac{\text{DWC} - \text{DWT}}{\text{DWC}} \times 100$$

Where, DWC is dry weight of weeds in weedy check i.e. control and DWT is weed dry weight of treatments.

Data transformation techniques are widely used especially in weed science for evaluating the efficacy of herbicide treatment, suitable transformations like square root should be done very carefully depending on the functional relationship existing between mean and variance of the weed count data. In weed science

experiment, we normally go for statistical transformation of data to bring it near to normal distribution. The purpose of the transformation is to reduce the variation within treatment. Data were recorded on weed count showed high variations. To make the analysis of variance more valid the data on weed count were subjected to square root transformation by using formula [sqrt (x+0.5)] as par suggested by Dey and Pandit (5).

RESULTS AND DISCUSSION

Weed flora data in Table 1, 2, 3 and 4 observed during 2014 and 2015 the crop period of tuberose was categorized as grasses, sedges and broad leaved weeds. Observations were recorded on weed count per m^2 area, fresh weight or dry weight of weeds (gm^2)at 25 days interval and weed control efficiency. Among the grasses, *Cynodon dactylon and Echinochloa colona* was predominant and only sedge observed was *Cyperus rotundus* and the minimum weed count was noted for *Portulaca quadrifoliara* followed by *Convolvulus arvensis*. In the present investigation the pre emergence application of Pendimethalin @ 1 kg/ha showed significantly lowest weed population, fresh weight and dry weight of weeds with highest weed control efficiency at 25 DAP (82.11, 83.27 % m^{-2}) and pendimethelin @ 0.75 kg/ha + 1 HW (40 days) at 50 DAP (91.68, 93.10 %

Table 1. Effect of weed management practices on weeds counts per m^2 area.

Treatments	Weeds counts per m^2 area (number)					
	25 days		50 days		75 days	
	2014	2015	2014	2015	2014	2015
Pendimethalin 0.75 kg/ha PE	4.82 (22.77)	4.70 (21.59)	4.86 (23.14)	4.72 (21.81)	5.00 (24.47)	4.85 (23.05)
Pendimethalin 1.0 kg/ha PE	4.31 (18.09)	4.17 (16.92)	4.80 (22.51)	4.66 (21.20)	4.93 (23.84)	4.79 (22.41)
Pendimethalin 0.75 kg/ha PE + 1 HW	4.61 (20.80)	4.49 (19.62)	3.87 (14.46)	3.69 (13.14)	4.04 (15.80)	3.85 (14.36)
Oxyfluorfen 0.50 kg/ha PE	4.72 (21.76)	4.59 (20.59)	5.03 (24.81)	4.90 (23.48)	5.16 (26.14)	5.02 (24.71)
Oxyfluorfen 0.75 kg/ha PE	4.65 (21.16)	4.53 (19.98)	5.00 (24.51)	4.87 (23.19)	5.13 (25.84)	4.99 (24.42)
Oxyfluorfen 0.50 kg/ha PE + 1 HW	4.70 (21.56)	4.57 (20.38)	4.03 (15.72)	3.86 (14.40)	4.19 (17.06)	4.01 (15.62)
Atrazine 1.0 kg/ha PE	5.23 (27.03)	5.13 (25.86)	5.41 (28.81)	5.29 (27.48)	5.54 (30.14)	5.40 (28.70)
Atrazine 1.5 kg/ha PE	5.18 (26.36)	5.05 (25.19)	5.30 (27.54)	5.15 (26.21)	5.42 (28.88)	5.29 (27.45)
Atrazine 1.0 kg/ha PE + 1 HW	5.24 (26.94)	5.12 (25.76)	4.07 (16.08)	3.91 (14.76)	4.23 (17.42)	4.06 (15.99)
Butachlor 1.0 kg/ha PE	5.35 (28.16)	5.24 (26.96)	5.74 (32.41)	5.62 (31.08)	5.84 (33.75)	5.73 (32.31)
Butachlor 1.5 kg/ha PE	5.25 (27.10)	5.12 (25.92)	5.65 (31.41)	5.53 (30.09)	5.77 (32.74)	5.64 (31.30)
Butachlor 1.0 kg/ha PE + 1 HW	5.35 (28.14)	5.24 (26.97)	4.24 (17.46)	4.08 (16.13)	4.39 (18.80)	4.23 (17.37)
3 HW at 30, 60 and 90 days interval	7.79 (60.18)	7.71 (58.99)	4.27 (17.76)	4.12 (16.44)	3.10 (9.10)	2.86 (7.68)
Weedy check (control)	8.66 (74.48)	8.59 (73.30)	9.14 (83.13)	9.25 (85.15)	9.40 (87.80)	9.36 (87.04)
CD at 5 %	0.25	0.36	0.11	0.26	0.20	0.16

The data without parenthesis represent the transformed values of square root (n+0.5).

Table 2. Effect of weed management practices on fresh weight of weeds per m^2 area.

Treatments	Fresh weight of weeds per m^2 area (g)					
	25 days		50 days		75 days	
	2014	2015	2014	2015	2014	2015
Pendimethalin 0.75 kg/ha PE	30.02	28.56	30.36	28.62	31.70	29.86
Pendimethalin 1.0 kg/ha PE	25.80	24.34	28.96	27.24	30.29	28.48
Pendimethalin 0.75 kg/ha PE + 1 HW	29.56	28.11	22.56	20.83	23.90	22.07
Oxyfluorfen 0.50 kg/ha PE	30.56	29.09	33.05	31.33	34.39	32.55
Oxyfluorfen 0.75 kg/ha PE	30.16	28.71	31.99	30.25	33.32	31.50
Oxyfluorfen 0.50 kg/ha PE + 1 HW	30.48	29.01	22.77	21.04	24.10	22.27
Atrazine 1.0 kg/ha PE	37.81	36.35	38.56	36.84	39.90	38.06
Atrazine 1.5 kg/ha PE	36.81	35.36	37.41	35.68	38.75	36.92
Atrazine 1.0 kg/ha PE + 1 HW	36.96	35.50	23.11	21.37	24.45	22.60
Butachlor 1.0 kg/ha PE	39.50	38.03	43.48	41.74	44.81	42.98
Butachlor 1.5 kg/ha PE	38.76	37.30	42.38	40.64	43.71	41.89
Butachlor 1.0 kg/ha PE + 1 HW	38.88	37.42	24.74	23.01	26.08	24.25
3 HW at 30, 60 and 90 days interval	107.38	105.90	24.89	23.16	20.23	18.37
Weedy check (control)	118.52	117.05	123.30	121.56	124.64	122.81
CD at 5 %	3.77	1.49	3.63	3.43	4.32	0.83

*The data transformation not required for fresh weight of weed.

Table 3. Effect of weed management practices on dry weight of weeds per m^2 area.

Treatments	Dry weight of weeds per m^2 area (g)					
	25 days		50 days		75 days	
	2014	2015	2014	2015	2014	2015
Pendimethalin 0.75 kg/ha PE	10.43	9.99	10.76	10.01	12.10	11.25
Pendimethalin 1.0 kg/ha PE	7.54	6.97	8.08	7.33	9.42	8.59
Pendimethalin 0.75 kg/ha PE + 1 HW	10.29	9.74	4.01	3.28	5.35	4.51
Oxyfluorfen 0.50 kg/ha PE	11.16	10.59	11.61	10.86	12.94	12.10
Oxyfluorfen 0.75 kg/ha PE	10.96	10.40	11.25	10.49	12.58	11.75
Oxyfluorfen 0.50 kg/ha PE + 1 HW	11.54	10.97	6.76	6.01	8.10	7.26
Atrazine 1.0 kg/ha PE	14.69	14.13	15.76	15.01	17.10	16.26
Atrazine 1.5 kg/ha PE	14.29	13.74	15.06	14.32	16.40	15.55
Atrazine 1.0 kg/ha PE + 1 HW	14.49	13.92	6.90	6.15	8.24	7.39
Butachlor 1.0 kg/ha PE	17.43	16.87	19.29	18.54	20.62	19.77
Butachlor 1.5 kg/ha PE	15.61	15.05	18.59	17.84	19.92	19.08
Butachlor 1.0 kg/ha PE + 1 HW	19.14	18.57	7.48	6.74	8.82	7.97
3 HW at 30, 60 and 90 days interval	38.11	37.55	8.01	7.27	5.25	4.40
Weedy check (control)	42.14	41.64	48.22	47.51	49.55	48.78
CD at 5%	2.08	1.52	0.93	1.09	1.27	1.80

*The data transformation not required for dry weight of weed.

Table 4. Effect of weed management practices on weed control efficiency (%).

Treatments	Weed control efficiency (%)					
	25 days		50 days		75 days	
	2014	2015	2014	2015	2014	2015
Pendimethalin 0.75 kg/ha PE	75.25	76.01	77.68	78.93	75.59	76.93
Pendimethalin 1.0 kg/ha PE	82.11	83.27	83.24	84.57	81.00	82.39
Pendimethalin 0.75 kg/ha PE + 1 HW	75.58	76.61	91.68	93.10	89.21	90.76
Oxyfluorfen 0.50 kg/ha PE	73.51	74.56	75.92	77.15	73.89	75.20
Oxyfluorfen 0.75 kg/ha PE	73.98	75.02	76.68	77.91	74.61	75.92
Oxyfluorfen 0.50 kg/ha PE + 1 HW	72.62	73.66	85.97	87.36	83.66	85.12
Atrazine 1.0 kg/ha PE	65.15	66.07	67.31	68.40	65.50	66.68
Atrazine 1.5 kg/ha PE	66.09	67.00	68.76	69.86	66.91	68.12
Atrazine 1.0 kg/ha PE + 1 HW	65.62	66.56	85.68	87.05	83.38	84.84
Butachlor 1.0 kg/ha PE	58.64	59.49	60.00	60.98	58.39	59.47
Butachlor 1.5 kg/ha PE	62.95	63.85	61.45	62.45	59.79	60.88
Butachlor 1.0 kg/ha PE + 1 HW	54.58	55.40	84.48	85.81	82.21	83.66
3 HW at 30, 60 and 90 days interval	9.56	9.82	83.38	84.69	89.41	90.98
Weedy check (control)	0.00	0.00	0.00	0.00	0.00	0.00
CD at 5 %	6.69	2.83	2.31	1.41	2.71	1.91

*The data transformation not required for weed control efficiency.

m^{-2} respectively). Whereas, the 3 HW at 30, 60 and 90 days interval at 75 DAP (89.41, 90.98 % m^{-2}) during 2014 and 2015 respectively, over the weedy check. However, the weedy check produced highest weeds population, fresh weight of weeds, dry weight of weed with lowest weed control efficiency at 25 DAP, 50 DAP and 75 DAP in the year 2014 and 2015, respectively.

At 25 DAP, the population of weeds, fresh weight of weeds and dry weight of weed were found minimum with the upper dose of the herbicidal treatment i.e. pre emergence application of pendimethalin @ 1 kg/ha. This may be due to the reason that herbicides at higher rates had longer persistence and showed a good control of weeds for longer period. This could be attributed to the fact that application of pendimethalin might have caused the death of relative weeds from starvation and oxidative damage caused by break down in electron transport process because of the herbicide functions by binding to the plasto-quinone binding protein in photosynthesis in gladiolus (Bhat and Sheikh, 3). At 50 DAP, the herbicide treatments in combination with one hand weeding at 40 days i.e. pendimethelin @ 0.75 kg/ha (PE) + 1 HW was superior and recorded better weed suppression compared to other treatments. This might be due to the effect of pre emergence herbicides coupled with hand weeding which clearly shows that herbicides alone treatments can check the weeds to some extents, but when coupled with hand weeding, shows remarkable results. In all the cases at 75 days weeds count was more as compared to three hand weeding treatment, due to herbicidal treatment imposed upto the 60 days only. Similar finding were reported by Desai (4) in gladiolus, Bala (2) or Kumar *et al.* (8) in chrysanthemum and Jeevan *et al.* (6) in tuberose cv. Hyderabad Single.

Weed control efficiency followed similar trends like then weed dry matter. Higher weed control efficiency under these treatments can be accounted to lower dry weight of weeds in these treatments. Whereas, the lowest weed control efficiency was observed in weedy check (control) due to poor or no control of weeds. All other treatments recorded comparatively higher weed control efficiency due to lower dry weight of weeds as compared to un-weeded control. The similar result suggested by Kumar *et al*. (9) in gladiolus, Jeevan *et al.* (6) in tuberose and Rathod and Venugopal (12) in tuberose cv. Prajwal.

The highest trends (Table 5) for vase life and water uptake were recorded in treatment 3 HW at 30, 60 and 90 days interval (7.93, 9.73 days and 58.86, 60.96 ml), which was at par with pendimethelin @ 0.75 kg/ha + 1 HW at 40 days (7.32, 9.06 days and 54.15, 56.17 ml), whereas, lowest trends noted in

weedy check (5.39, 6.43 days and 44.09, 45.35 ml), during 2014 and 2015, respectively. The highest vase life of cut spike in lab condition is desirable trait rather than lowest value for the similar trait. These results might be due to better control of weeds during crop period in these treatments and also no phytotoxicity effects on the crop growth period which resulted in better growth and quality flower in tuberose. Shalini and Patil (14), while working on gerbera observed the above treatments found superior due to the fact that the crop plants in these treatments reported good vegetative growth right from the early stages of growth period to the end of cropping period, because of less competition of weeds for nutrients, water, space and sunlight which might have resulted in higher photosynthetic activity and higher number of florets per plant. Similar finding was also reported by Rathod and Venugopal (12) the higher vase life of the spike may be due to improved water uptake by xylem system, resulted in more cell turgidity, and accumulation of carbohydrates, which is transported from leaf (source) to florets and bulbs act as sink in tuberose cv. Prajwal

Among the integrated weed management practices (Table 5) maximum loose flower yield/ha and bulb/ha were recorded in 3 HW at 30, 60 and 90 days interval (5285, 13847 kg and 279459, 985800 ha^{-1}), followed by pendimethelin @ 0.75 kg/ha + 1 HW at 40 days (5116, 13508 kg and 262342, 947800 ha^{-1})**,** whereas, minimum were observed in weedy check (2580, 7977 kg and 89910, 565000 ha^{-1}) in the year 2014 and 2015, respectively. The three hand weeding and pendimethelin @ 0.75 kg/ha + 1 HW at 40 days treatments lower down the weed competition with tuberose for space, light, improve photosynthesis, aeration, nutrient availability, uptake by the roots of plants and finally improve source sink relationship resulted in higher flower and bulb yield . Whereas, weedy check were recorded less flower weight per plant as well as per hectare due to higher weed density which resulted in higher competition of weeds with the crop plants that ultimately suppressed the growth and flowering of tuberose. Hand weeding at 20, 40 and 60 DAP and pendimethelin @ 0.75 kg/ha + 1 HW at 30 days play a major impact on yield parameter reported by Jeevan *et al.* (6) in tuberose cv. Hyderabad Single. Similar results were obtained by Kumar *et al*. (9) highest spike ha^{-1} with 2 HW at 20 and 40 DAT followed by pendimethalin @ 2 kg/ha + 1 HW in gladiolus and Rathod and Venugopal (12) were recorded maximum loose flower yield ha^{-1} and bulb yield ha^{-1}in weed free check followed by pendimethalin @ 1 kg a.i./ha in tuberose cv. Prajwal.

Economic parameters were also calculated for various weed management strategies in tuberose under study revealed (Table 6 and 7) that highest return from loose flowers, bulb, gross return and net return ha^{-1} were reported in 3 HW at 30, 60 and 90

Table 5. Effect of weed control treatments on vase life and yield parameters.

Treatments	Vase life (days)		Water uptake (ml)		Flower yield/ha (kg)		No. of bulbs/ha	
	2014	2015	2014	2015	2014	2015	2014	2015
Pendimethalin 0.75 kg/ha PE	6.85	8.25	50.04	51.69	3936	11153	196126	800800
Pendimethalin 1.0 kg/ha PE	6.89	8.43	50.32	52.12	4274	11612	202252	814400
Pendimethalin0.75 kg/ha PE + 1 HW	7.32	9.06	54.15	56.17	5116	13508	262342	947800
Oxyfluorfen0.50 kg/ha PE	6.07	7.40	49.71	51.28	3540	10299	182973	771600
Oxyfluorfen0.75 kg/ha PE	6.21	7.74	50.34	52.12	4209	11425	192252	792200
Oxyfluorfen0.50 kg/ha PE + 1 HW	7.09	8.75	51.69	53.64	4718	12386	256000	889200
Atrazine 1.0 kg/ha PE	6.26	7.53	49.40	50.90	3501	10419	188919	784800
Atrazine 1.5 kg/ha PE	6.31	7.71	49.75	51.39	3893	11065	191802	791200
Atrazine 1.0 kg/ha PE + 1 HW	7.04	8.71	51.66	53.60	4365	11912	218288	850000
Butachlor1.0 kg/ha PE	5.64	6.80	47.23	48.62	3141	9816	155946	711600
Butachlor1.5 kg/ha PE	6.01	7.21	49.32	50.75	3393	10401	164775	731200
Butachlor1.0 kg/ha PE + 1 HW	7.10	8.64	50.78	52.58	4322	11740	190901	789200
3 HW at 30, 60 and 90 days interval	7.93	9.73	58.86	60.96	5285	13847	279459	985800
Weedy check (control)	5.39	6.43	44.09	45.35	2580	7977	89910	565000
CD at 5 %	0.54	0.68	4.28	4.38	719.95	1329.81	49663.84	109260.67

days interval (₹ 422800, 1107760, ₹ 279459, 985800, ₹ 702259, 2093560 and ₹ 430394, 1988180), followed by pendimethelin @ 0.75 kg/ha + 1 HW at 40 days (₹ 409280, 1080640, ₹ 262342, 947800, ₹ 671622, 2028440 and ₹ 409751, 1933054) over the weedy check (₹ 206400, 638160, ₹ 89910, 565000, ₹ 296310, 1203160 and ₹ 40707, 1114042) during 2104 and 2015, respectively. Among various treatments the return per rupee investment (BC ratio) was maximum noted in pendimethelin @ 0.75 kg/ha + 1 HW at 40 days (₹ 1.56, 20.27), whereas, the lowest benefit cost ratio (₹ 0.16, 12.50) was recorded in weedy check, in the both years respectively. This might be due to the effect of pre emergence herbicides coupled with hand weeding which clearly shows that herbicides alone treatments can check the weeds to some

Table 6. Economic feasibility of different treatment in tuberose cv. Prajwal on the basis of two year.

Treatments	Total cost of production (₹)		Returns from loose flowers/ha (₹)		Returns from bulbs/ ha (₹)	
	2014	2015	2014	2015	2014	2015
Pendimethalin 0.75 kg/ha PE	256450	89965	314880	892240	196126	800800
Pendimethalin 1.0 kg/ha PE	256721	90236	341920	928960	202252	814400
Pendimethalin0.75 kg/ha PE + 1 HW	261871	95386	409280	1080640	262342	947800
Oxyfluorfen0.50 kg/ha PE	256856	90372	283200	823920	182973	771600
Oxyfluorfen0.75 kg/ha PE	257489	91004	336720	914000	192252	792200
Oxyfluorfen0.50 kg/ha PE + 1 HW	262277	95792	377440	990880	256000	889200
Atrazine 1.0 kg/ha PE	256391	89906	280080	833520	188919	784800
Atrazine 1.5 kg/ha PE	256786	90301	311440	885200	191802	791200
Atrazine 1.0 kg/ha PE + 1 HW	261812	95327	349200	952960	218288	850000
Butachlor1.0 kg/ha PE	256157	89672	251280	785280	155946	711600
Butachlor1.5 kg/ha PE	256434	89950	271440	832080	164775	731200
Butachlor1.0 kg/ha PE + 1 HW	261578	95093	345760	939200	190901	789200
3 HW at 30, 60 and 90 days interval	271865	105380	422800	1107760	279459	985800
Weedy check (control)	255603	89118	206400	638160	89910	565000

Table 7. Economic feasibility of different treatment in tuberose cv. Prajwal on the basis of two year.

Treatments	Gross return (₹)		Net return (₹)		BC ratio	
	2014	2015	2014	2015	2014	2015
Pendimethalin 0.75 kg/ha PE	511006	1693040	254556	1603075	0.99	17.82
Pendimethalin 1.0 kg/ha PE	544172	1743360	287451	1653124	1.12	18.32
Pendimethalin0.75 kg/ha PE + 1 HW	671622	2028440	409751	1933054	1.56	20.27
Oxyfluorfen0.50 kg/ha PE	466173	1595520	209317	1505148	0.81	16.66
Oxyfluorfen0.75 kg/ha PE	528972	1706200	271483	1615196	1.05	17.75
Oxyfluorfen0.50 kg/ha PE + 1 HW	633440	1880080	371163	1784288	1.42	18.63
Atrazine 1.0 kg/ha PE	468999	1618320	212608	1528414	0.83	17.00
Atrazine 1.5 kg/ha PE	503242	1676400	246456	1586099	0.96	17.56
Atrazine 1.0 kg/ha PE + 1 HW	567488	1802960	305676	1707633	1.17	17.91
Butachlor1.0 kg/ha PE	407226	1496880	151069	1407208	0.59	15.69
Butachlor1.5 kg/ha PE	436215	1563280	179781	1473330	0.70	16.38
Butachlor1.0 kg/ha PE + 1 HW	536661	1728400	275083	1633307	1.05	17.18
3 HW at 30, 60 and 90 days interval	702259	2093560	430394	1988180	1.58	18.87
Weedy check (control)	296310	1203160	40707	1114042	0.16	12.50

extents, but when coupled with hand weeding, shows remarkable results. Similar trend were reported by Desai (4) for highest net return and benefit cost ratio were obtained in gladiolus cv. White Prosperity by controlling of weeds with application of pendimethalin @ 0.75 kg a.i/ha + 1 HW at 50 DAP and Kumar *et al*. (9) were also observed similar result for highest benefit cost ratio in gladiolus with application of pendimethalin along with 1 HW and as compared to other treatment proved to be economical.

From the two year investigation it is recommended that the highest weed control efficiency with remarkable increase in loose flower yield kg ha^{-1} and bulb ha^{-1} due to an application of pendimethelin @ 1.0 kg active ingredient / ha, pendimethelin @ 0.75 kg active ingredient / ha + 1 HW at 40 days and 3 hand weeding at 30, 60 and 90 days interval over the weedy check. Manual weeding is time consuming and as the cost of labour is more hence, weed can be manage by combination of pendimethelin @ 0.75 kg a.i. / ha + 1 HW at 40 days was better which is statistically at par with 3 hand weeding at 30, 60 and 90 days interval in tuberose.

DECLARATION

The authors declare no conflict of interest.

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