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Integrated weed management practices in gladiolus and their effect on flowering, weed density and corm yield

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ABSTRACT

An experiment was during *Rabi* (winter) season of 2014-15 to study on integrated weed management in gladiolus cv. Pusa Srijana. A set of 11 integrated weed management treatments laid out in simple randomized block design with three replications. The results revealed that the number of monocot and dicot weeds, their fresh and dry weight was recorded maximum under control treatment, while these were least with the application of atrazine 0.75 kg/ha pre-emergence + carfentrazone @ 0.030 kg/ha post-emergence at 40 days after planting. The maximum vase life of spikes (10.3 day) was recorded with the application of pendimethalin 0.75 kg/ha + metribuzin 0.3 kg/ha pre-emergence as compared to control (7.3 day). The yield of corms 89.48 q/ha & cormels and marketable spikes (1.43 lakh per ha), net profit (Rs. 3.48 lakh/ha) and benefit:cost ratio (1.99) was received maximum with the application of metribuzin 0.4 kg/ha pre-emergence + residue (dry grass 5.0 tonnes/ha) over control.

Key words: Gladiolus, herbicide, mulching, weed management.

INTRODUCTION

Gladiolus is an important cut flower crop commercially grown in many tropical, sub-tropical and temperate parts of the world. It is popular for its attractive spikes having florets of huge form, dazzling colours varying sizes and long keeping quality. In the modern agriculture, the weed control is becoming essential for higher yield of gladiolus. The early emergence and faster growth of weeds causes severe competition with crops for light, moisture, space and nutrients, resulting in yield losses up to 50-100% (Meena *et al*., 7). Employing labour increases cost of cultivation and affects successful commercial flower production. Manual weed control is effective if done frequently, but this procedure is very expensive. Integrated weed management is effective, economic and eco-friendly approach in improving and sustaining the agricultural productivity (Foy, 4). Research and development in herbicide technology has opened up new possibilities for chemical and integrated weed management practices. This type of information could be very useful in economizing the cost of cultivation of any crop (Singh *et al*., 11). Therefore, the present experiment was undertaken to evaluate the comparative performance of herbicides alone and weedicide combinations on.

MATERIALS AND METHODS

A field experiment was carried out on gladiolus cv. Pusa Srijana at the experimental farm of the Division of Floriculture and Landscaping, ICAR-IARI, New Delhi, during *Rabi* season of 2014-2015. The experiment was planted on 30th October in 2014, which laid out in randomized complete block design with 11 treatments and replicated thrice. Row to row distance 40 cm and plant to plant 15 cm was maintained in a plot size of 2.5 to 2.0 m. The weed control treatments imposed were T_1 = Atrazine (50% WP) (Attack™, Devidayal Agro Chemicals, India) @ 1.0 kg/ha pre-emergence, T_2 = Atrazine 0.75 kg/ha pre-emergence + metsulfuron-methyl (20% WP) (Devimet™, Devidayal Agro Chemicals, India) @ 0.005 kg/ha post- emergence at 40 DAS, T_3 = Atrazine 0.75 kg/ha pre-emergence + Carfentrazone (40% DF) (Quicksilver T&O 1.9 L, NABOOD, India) @ 0.030 kg/ha post-emergence at 40 DAP), T_4 = Atrazine 0.75 kg/ha pre-emergence + residue (dry grass 5 tonnes/ha, T_5 = Metribuzin (70% WP) (Encore®, Devidayal Agro Chemicals, India)) @ 0.4 kg/ha pre-emergence + residue (dry grass 5 tonnes/ha), T_6 = Metribuzin 0.4 kg/ha pre-emergence + metsulfuron-methyl @ 0.005 kg/ha post-emergence at 40 DAS), T_7 = Pendimethalin (30% EC) (Depend®, Rallis, A Tata Enterprise, India) @1.0 kg/ha pre-emergence + residue (dry grass 5 tonnes/ha), T_8 = Pendimethalin 0.75 kg/ha pre-emergence + carfentrazone @ 0.030 kg/ha post emergence at 40 DAS, T_9 = Pendimethalin @ 0.75 kg/ha + metribuzin 0.3 kg/ha (tank-mix) pre-emergence,T_{10} = Weed-free check (4 hand weeding), and T_{11} = weedy check. Hand weeding and weedy check treatments were kept for comparison with

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weedicides treatments. A uniform dose of 120 kg N, 80 kg P_2O_5, 80 kg K_2O/ha were applied to the crop as basal dose. Pre-emergence herbicides, residue and post-emergence herbicides were applied treatment-wise after planting and thereafter 40 days after planting of corms with the help of a hand operated knapsack sprayer fitted with flat-fan nozzle. Uniform size of gladiolus corms (4.0-5.0 cm), cv. Pusa Srijana was planted in end October. The data for weed density, weed counting, fresh and dry weight of weeds were collected at 40 and 90 days after planting, while other growth, flowering, yield and corms attributes were collected at their appropriate time. Weed observation were recorded twice at 40 and 90 days after planting from one place in each plot using 50 cm x 50 cm quadrate. Weeds were pulled out, washed with tap water, counted and weighed for fresh weight and then sun-dried and again weighed.

RESULTS AND DISCUSSION

The different weed species observed were *Cyperus rotundus*, *Digitaria adscendance* and *Echinochloa crusgalli*, *Chenopodium album*, *Convolvulus arvensis*, *Digera arvensis*, *Euphorbia hirta* and *Parthenium hysterophorus* (Table 1). Minimum (3.0 g/m^2) monocot population were found in T_5, *i.e*. application of metribuzin 0.4 kg/ha pre-emergence + residue (dry grass 5 tonnes/ ha). This might be due to reduced germination and emergence of weeds due to pre-emergence application of metribuzin as it controls the weeds by inhibiting photosystem II by disrupting electron transfer. This results in death due to starvation in the target plant. Kumar *et al*. (6) reported in gladiolus that highest weed control efficiency (78.2%) was achieved with two hand weeding, followed by pendimethalin + hand weeding 76.9%). T_{11} (control) significantly recorded the maximum (148.3 g/m^2) dicot weed population and minimum (1.3 g/m^2) dicot weed population was recorded by T_2 (atrazine 0.75 kg/ha pre-emergence + metsulfuron-methyl @ 0.005 kg/ ha post-emergence at 40 DAS). This might be due to reduced emergence of weeds due to application of atrazine and metsulfuron-methyl as it controls weeds by inhibiting hill reaction, cell division in the shoot and root of the weeds. T_4 (atrazine 0.75 kg/ha pre-emergence + residue (dry grass 5.0 t/ha) had recorded

Table 1. Effect of integrated weed management on the populations and fresh and dry weight of monocot and dicot weeds in gladiolus.

Treatment	Monocot weed population (No./ 0.25 m^2)	Dicot weed population (No./ 0.25 m^2)	Monocot + dicot weed fresh weight (g/ 0.25 m^2)	Monocot + dicot weed dry weight (g/ 0.25 m^2)
T_1 = Atrazine 1.0 kg/ha pre-emergence	7.7	5.0	10.00	2.03
T_2 = Atrazine 0.75 kg/ha pre-emergence + metsulfuron-methyl @ 0.005 kg/ha post-emergence at 40 DAS	5.3	1.3	6.23	1.22
T_3 = Atrazine 0.75 kg/ha pre-emergence + carfentrazone @ 0.030 kg/ha post-emergence at 40 DAS	5.7	4.7	4.66	0.76
T_4 = Atrazine 0.75 kg/ha pre-emergence + residue (dry grass 5 tonnes/ ha)	6.0	5.7	3.03	0.89
T_5 = Metribuzin 0.4 kg/ha pre-emergence + residue (dry grass 5 tonnes/ ha)	3.0	5.0	5.23	1.34
T_6 = Metribuzin 0.4 kg/ha pre-emergence + metsulfuron-methyl @ 0.005 kg/ha post-emergence at 40 DAS	20.3	5.0	14.66	2.70
T_7 = Pendimethalin 1.0 kg/ha pre-emergence + residue (dry grass 5 tonnes/ha)	5.5	4.7	16.11	3.39
T_8 = Pendimethalin 0.75 kg/ha pre-emergence + carfentrazone @ 0.030 kg/ha post emergence at 40 DAS	6.3	4.7	15.03	2.35
T_9 = Pendimethalin 0.75 kg/ha + metribuzin 0.3 kg/ha (tank-mix) pre-emergence	6.3	8.0	7.46	1.55
T_{10} = Weed-free check (4 hand weedings)	0	0	0	0
T_{11} = Weedy check	69.0	148.3	216.66	35.10
$CD_{(p\leq0.05)}$	1.1	1.8	2.13	1.22

the minimum (3.03 g/m^2) fresh weight of monocot and dicot weeds over control. The maximum (216.66 & 35.10 g/m^2) fresh and dry weight of monocot and dicot weeds was recorded under control because of the prolonged growth period available to weeds in the field. Swaroop *et al*. (12) reported in an experiment of gladiolus that among herbicide treatments, atrazine 1.0 kg/ha pre-emergence followed by rice residue @ 5 tonnes/ha at 2 days after atrazine application caused the greatest reduction in density and dry weight of weeds.

Application of metribuzin @ 0.4 kg/ha pre-emergence + metsulfuron-methyl @ 0.005 kg/ha post-emergence at 40 days after sowing significantly reduced the days for 50% sprouting as compared to other treatments and control (Table 2). Treatments T_1 and T_9 had taken more days, 14.3 and 14.0 days, respectively for 50% plants to sprout over control. Similar results reported by Shalini *et al*. (10) in gerbera. Maximum sprouting at 30 days after planting (89.16%) was recorded with the application of atrazine 0.75 kg/ha pre-emergence + carfentrazone @ 0.030 kg/ha post-emergence at 40 days after planting over control followed by T_4 and T_5 which had recorded sprouting of 87.55 and 87.08%, respectively as compared to control (82.08%). The minimum sprouting at 30 days after planting (76.25%) was recorded with the application of atrazine 0.75 kg/ha pre-emergence + metsulfuron-methyl @ 0.005 kg/ha post-emergence at 40 days after planting. The maximum plant height was recorded with T_{10}, *i.e*. weed-free check (four hand weeding) than that of control and other treatments. This might be due to weed-free environment, especially at critical period of crop-weed competition growth, which might have resulted in increased production and translocation of photosynthesis sufficient to supply the sink needs (El-Hamid, 3). This is in conformity with the findings of Murthy and Gowda (8) and Pal and Das (9) on tuberose. The minimum plant height was recorded with the T_6, *i.e*. application of metribuzin 0.4 kg/ha pre-emergence + metsulfuron-methyl @ 0.005 kg/ha post-emergence at 40 days after planting. Bhat *et al*. (2) also found the significant variation in vegetative, reproductive parameters with the application of pendimethalin 1.5 kg a.i. ha^{-1}. Kadam *et al*. (5) and Ali *et al*. (1) reported that pre-emergence application of pendimethalin had superior effect on the plant height. The application of metribuzin 0.4 kg/ha pre-emergence + metsulfuron-methyl @ 0.005 kg/ha post-emergence at 40 days after planting (T_6)

Table 2. Effect of integrated weed management on vegetative growth characters and flowering of gladiolus cv. Pusa Srijna

Treatment	Days to 50% sprouting	Sprouting at 30 DAP (%)	Plant height (cm)	Days to first floret opening	Days to 50% blooming	Spike length (cm)	Rachis length (cm)
T_1 = Atrazine 1.0 kg/ha pre-emergence	14.3	79.55	77.3	112.3	116.3	58.6	34.8
T_2 = Atrazine 0.75 kg/ha pre-emergence + metsulfuron-methyl @ 0.005 kg/ha post-emergence at 40 DAS	12.3	76.25	49	111.0	118.0	31.8	22.8
T_3 = Atrazine 0.75 kg/ha pre-emergence + carfentrazone @ 0.030 kg/ha post-emergence at 40 DAS	13.7	89.16	63.0	110.2	117.0	46.2	29.5
T_4 = Atrazine 0.75 kg/ha pre-emergence + residue (dry grass 5 tonnes/ha)	12.3	87.55	87.7	113.3	115.3	65.8	39.8
T_5 = Metribuzin 0.4 kg/ha pre-emergence + residue (dry grass 5 tonnes/ha)	13.7	87.08	86.8	111.5	116.0	67.4	41.4
T_6 = Metribuzin 0.4 kg/ha pre-emergence + metsulfuron-methyl @ 0.005 kg/ha post-emergence at 40 DAS	12.0	81.66	47	114.7	118.3	31.4	19.0
T_7 = Pendimethalin 1.0 kg/ha pre-emergence + residue (dry grass 5 tonnes/ha)	13.0	85.41	81.4	113.7	115.0	59.2	40.3
T_8 = Pendimethalin 0.75 kg/ha pre-emergence + carfentrazone @ 0.030 kg/ha post emergence at 40 DAS	12.7	85.83	90.2	111.9	114.3	69.3	42.9
T_9 = Pendimethalin 0.75 kg/ha + metribuzin 0.3 kg/ha (tank-mix) pre-emergence	14.0	84.58	88.2	112.1	113.7	65.5	40.6
T_{10} = Weed-free check (4 hand weeding)	13.0	84.58	90.3	113.3	115.3	68.5	39.4
T_{11} = Weedy check	12.3	82.08	86.2	112.0	115.3	65.0	37.3
$CD_{(p<0.05)}$	1.02	1.73	1.37	1.05	1.29	1.54	0.85

had taken more days for first floret opening and 50% blooming over control; but minimum days for first floret opening and 50% blooming was recorded in T_3, *i.e.* application of atrazine 0.75 kg/ha pre-emergence + carfentrazone @ 0.030 kg/ha post-emergence at 40 days after planting and T_9, *i.e.* pendimethalin 0.75 kg/ha + metribuzin 0.3 kg/ha pre-emergence. This could be because of least competition by the weeds in the treatments T_3 and T_9, which makes available the required nutrients, air and free space to crop plants. The application of pendimethalin 0.75 kg/ha pre-emergence + carfentrazone @ 0.030 kg/ha post-emergence at 40 days after planting (T_8) had increased the spike length (69.3 cm) and rachis length (42.9 cm). This might be attributed to the better availability of nutrients, sunlight and less crop weed competition; whereas, minimum spike length (31.4 cm) and rachis length (19.0 cm) was recorded in treatment T_6 as compared to control (65.0 cm). Kadam *et al*. (5) also reported that pre-emergence application of pendimethalin @ 1.0 kg a.i./ha had superior effect on the spike length (98.3 cm) and rachis length (58.8 cm). The number of florets/ spike was significantly higher in T_{10}, *i.e.* weed-free check (4 hand weedings) over other treatments and control (Table 3). The least number of florets (10.7) per spike was recorded in T_6. This could be because of least competition by the weeds in the weed-free plots, which makes available the required nutrients air and free space to crop plants. Maximum days (123.7) to last floret opening was noted with treatment T_6 as compared to control (121.3 day), but the minimum days (120.3) to last floret opening was recorded with T_9, *i.e*. application of pendimethalin 0.75 kg/ha + metribuzin 0.3 kg/ha (tank-mix) pre-emergence.

xMaximum plant fresh weight (65.4 g) and dry weight were recorded when plants grown under T_{10}, *i.e.* weed free check and minimum plant fresh and dry weight were recorded under T_2, *i.e.* application of 0.75 kg/ha pre-emergence + metsulfuron-methyl @ 0.005 kg/ha post-emergence at 40 days after planting and the application of atrazine 0.75 kg/ha pre-emergence + carfentrazone @ 0.030 kg/ha post-emergence at 40 days after planting. This could be because of least competition by the weeds in the weed free plots which makes available the required nutrients, air and free space to crop plants. Maximum days for spike vase-life in tap water (10.3

Table 3. Effect of integrated weed management strategies on spike quality and vase-life of gladiolus.

Treatment	Florets/ spike	Days to last floret opening	Fresh weight (g/plant)	Dry weight (g/plant)	Spike vase-life in tap water (days)
T_1 = Atrazine 1.0 kg/ha pre-emergence	14.4	122.8	51.9	11.4	9.3
T_2 = Atrazine 0.75 kg/ha pre-emergence + metsulfuron-methyl @ 0.005 kg/ha post-emergence at 40 DAS	11.1	122.8	38.6	11.8	8.7
T_3 = Atrazine 0.75 kg/ha pre-emergence + carfentrazone @ 0.030 kg/ha post-emergence at 40 DAS	12.3	122.5	40.4	10.7	9.3
T_4 = Atrazine 0.75 kg/ha pre-emergence + residue (dry grass 5 tonnes/ha)	15.3	121.5	53.3	12.7	9.3
T_5 = Metribuzin 0.4 kg/ha pre-emergence + residue (dry grass 5 tonnes/ha)	14.7	122.0	44.7	11.3	9.3
T_6 = Metribuzin 0.4 kg/ha pre-emergence + metsulfuron-methyl @ 0.005 kg/ha post-emergence at 40 DAS	10.7	123.7	40.3	12.0	8.0
T_7 = Pendimethalin 1.0 kg/ha pre-emergence + residue (dry grass 5 tonnes/ha)	14.2	121.0	59.7	15.1	9.0
T_8 = Pendimethalin 0.75 kg/ha pre-emergence + carfentrazone @ 0.030 kg/ha post emergence at 40 DAS	15.2	121.0	55.7	11.2	8.7
T_9 = Pendimethalin 0.75 kg/ha + metribuzin 0.3 kg/ha (tank-mix) pre-emergence	14.9	120.3	53.7	11.6	10.3
T_{10} = Weed-free check (4 hand weeding)	15.3	121.5	65.4	16.4	9.7
T_{11} = Weedy check	13.3	121.3	52.8	11.0	7.3
$CD_{(p\leq0.05)}$	0.90	1.5	1.8	1.1	1.9

days) was observed in treatment T_9, *i.e.* application of pendimethalin 0.75 kg/ha + metribuzin 0.3 kg/ha (tank-mix) pre-emergence; whereas, it was minimum (7.3 days) in control (T_{11}).

The application of metribuzin 0.4 kg/ha pre-emergence + residue (dry grass 5.0 t/ha) produced the maximum marketable spikes (1.43 lakh) per ha as compared to control (0.18 lakh). Higher spike yield (Table 4) might be attributed to the availability of nutrients, moisture and less competition from weeds for sunlight and space. The lowest marketable spike (0.18 lakh) was obtained in weedy check. This was due to severe weed competition, which ultimately resulted in lower yield. Similar results were also obtained by Swaroop *et al*. (12) in gladiolus. The plants grown under T_{10}, *i.e.* weed free check had produced significantly higher number of corms/ plant (1.8), cormels/ plant (16.3), weight of cormel/ plant (5.5 g) and weight of corm/ plant (57.8 g), T_{11} (control) had produced minimum number of corms/ plant (1.0), cormels/ plant (3.6), weight of cormel/ plant (1.9 g), weight of corm/ plant (23.0 g) due to heavy weed infestation. T_5, *i.e*. application of metribuzin 0.4 kg/ha pre-emergence + residue (dry grass 5.0 tonnes/ha) produced the maximum corms yield and cormels yield. This could be due to reduced weed competition and promoting crop growth, which provided a favourable environment for growth.

The maximum net profit (Rs. 3.48 lakh/ ha) and benefit: cost ratio (1.99) was obtained in T_5 (Table 5), *i.e.* application of metribuzin 0.4 kg/ha pre-emergence + residue (dry grass 5 tonnes/ha). This could be due to reduced weed competition and promoting crop growth, which provided a favourable environment for growth; whereas, T_{11}, *i.e.* control treatment (weedy check) gave the lowest benefit cost ratio (-0.34) due to heavy weed infestation.

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Table 4. Effect of integrated weed management on spike yield, corm and cormel production in gladiolus cv. Pusa Srijna.

Treatment	Marketable spikes (lakh/ha)	Corms (No./ plant)	Cormels (No./ plant)	Corm weight (g/plant)	Cormel weight (g/plant)
T_1 = Atrazine 1.0 kg/ha pre-emergence	1.27	1.3	5.6	32.3	2.3
T_2 = Atrazine 0.75 kg/ha pre-emergence + metsulfuron-methyl @ 0.005 kg/ha post-emergence at 40 DAS	1.25	1.0	5.0	25.0	2.1
T_3 = Atrazine 0.75 kg/ha pre-emergence + carfentrazone @ 0.030 kg/ha post-emergence at 40 DAS	1.23	1.3	5.6	26.9	2.3
T_4 = Atrazine 0.75 kg/ha pre-emergence + residue (dry grass 5 tonnes/ha)	1.41	1.7	7.1	50.4	3.0
T_5 = Metribuzin 0.4 kg/ha pre-emergence + residue (dry grass 5 tonnes/ha)	1.43	1.5	7.1	48.3	3.0
T_6 = Metribuzin 0.4 kg/ha pre-emergence + metsulfuron-methyl @ 0.005 kg/ha post-emergence at 40 DAS	1.17	1.4	4.6	37.3	1.9
T_7 = Pendimethalin 1.0 kg/ha pre-emergence + residue (dry grass 5 tonnes/ha)	1.31	1.8	7.3	48.0	3.3
T_8 = Pendimethalin 0.75 kg/ha pre-emergence + carfentrazone @ 0.030 kg/ha post emergence at 40 DAS	1.34	1.7	8.3	48.5	3.8
T_9 = Pendimethalin 0.75 kg/ha + metribuzin 0.3 kg/ha (tank-mix) pre-emergence	1.34	1.7	7.7	47.4	3.2
T_{10} = Weed-free check (4 hand weeding)	1.31	1.8	16.3	57.8	5.5
T_{11} = Weedy check	0.18	1.0	3.6	23.0	1.9
$CD_{(p<0.05)}$	0.061	0.1	0.8	1.5	0.37

Table 5. Economics (Rs.) of different weed management strategies in gladiolus production.

Treatment	Corm and cormel yield (q/ ha)	Spike (lakh/ ha)	Returns from corms (lakh Rs./q) (A)	Returns from spike (lakh Rs./ ha) (B)	Total gross returns (lakh Rs./ ha) (A+ B)	Common cost of cultivation (lakh Rs./ ha)	Treatment cost (Rs./ ha)	Total cost of production (lakh Rs./ ha)	Net returns (lakh Rs./ ha)	Benefit: cost ratio
T_1	43.59	1.27	1.30	3.81	5.12	3.44	600	3.45	1.66	1.48
T_2	32.88	1.25	0.98	3.77	4.75	3.44	613	3.45	1.30	1.37
T_3	40.70	1.22	1.22	3.67	4.88	3.44	885	3.45	1.42	1.41
T_4	77.34	1.41	2.32	4.22	6.54	3.44	5450	3.50	3.04	1.86
T_5	89.48	1.43	2.68	4.31	6.99	3.44	6000	3.50	3.48	1.99
T_6	51.82	1.17	1.55	3.52	5.07	3.44	1163	3.46	1.61	1.46
T_7	72.46	1.31	2.17	3.93	6.11	3.44	5500	3.50	2.60	1.74
T_8	74.47	1.34	2.23	4.02	6.25	3.44	885	3.45	2.79	1.80
T_9	70.63	1.34	2.11	4.02	6.13	3.44	1200	3.46	2.67	1.77
T_{10}	74.56	1.31	2.23	3.93	6.17	3.44	20,475	3.65	2.51	1.68
T_{11}	21.20	0.18	0.63	0.63	1.17	3.44	Nil	3.44	-2.27	-0.34

1. Rate of corms @ Rs. 3,000 / q, 2. Rate of spikes @ Rs. 3.00 per spike

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