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Evaluation of different weed management practices on gladiolus (*Gladiolus grandiflorus* L.) cv. American Beauty

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Abstract
The present experiment entiled "Evaluation of different weed management practices on gladiolus (*Gladiolus grandiflorus* L.) cv. American Beauty" was studied at the Research Farm, Borsi, Dau Kalyan Singh Agriculture College and Research Station, Bhatapara, Indira Gandhi Krishi Vishwavidyalaya, Raipur, (C.G.) during *rabi* season of the year 2018-19. The experiment was conducted in a Randomized Block Design (RBD), having eleven treatments with three replications. The result indicated that among the different treatments of weed management practices on gladiolus production treatment T_5 (Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} + 1 hand weeding 30 DAP + Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1}) was registered significantly maximum plant height (65.14 cm), number of leaves (12.34) $plant^{-1}$, number of shoots (2.89) $plant^{-}$,[1] number of spikes (3.00) $plant^{-1}$, spike length (59.67 cm), number of florets (12.13) $spike^{-1}$, diameter of basal floret (12.67 cm). Whereas, significantly minimum days required to 50% spike initiation (60.21 days) and days taken for 50% flowering (71.84 days) were also noticed with same treatment in gladiolus during experiment.

Keywords: Gladiolus, weed management

Introduction
Gladiolus (*Gladiolus grandiflorus* L.) belong to the family Iridaceae with chromosome number n=15. Gladiolus is one among the foremost popular flowers with magnificent inflorescence, referred as "Queen of bulbous flowers". It is native of South Africa and Tropical Africa. The most important yield limiting factors are weeds. Weeds cause heavy damage to crop by competing with them for water, nutrients, light and space besides acting as alternate hosts to a number of pathogens and insect pests. They compete with crop resulting in the production of poor quality spikes and unhealthy corms. During this critical period (45 DAP), removal of weeds by herbicides or cultural means is much needed. Manual weeding is traditional and very effective practice. Generally, 2-3 hand weddings are required in Gladiolus under Chhattisgarh plain conditions. Kumar *et al.* (2012) [6] observed that the cost of cultivation increases by employing labor and adversely affects the successful commercial flower production in Gladiolus and more over manual weeding requires skilled labor because if it is not done properly it may damage plants or corms and hence finding an option of mulching and chemical control. So, to design a successful integrated weed management program we must include combinations of herbicidal measures, taking into consideration labour costs and availability of locally available mulching materials. Mulching is a cultural practice aimed to conserve soil moisture, regulate soil temperature, control weed growth and reduce soil erosion. It is also helpful for nutrient availability to plants and ensures better yield with higher quality. Chemical weed control is one of the effective methods for checking the early weed growth, because, about 60 per cent of the weeds emerge during first four weeks after planting and pose severe competition with the crop plants. Therefore, timely weed control at early stage is much needed to reach to the profitable level of productivity. The use of herbicides provides selective and economic management of weeds right from the beginning, thus providing the crop an advantage of good start and competitive superiority.

Methods and Materials
The experiment was studied at the Research Farm, Borsi, Dau Kalyan Singh Agriculture College and Research Station, Bhatapara, Indira Gandhi Krishi Vishwavidyalaya, Raipur,

(C.G.) during *rabi* season of the year 2018-19. The experiment was conducted in Randomized Block Design (RBD), having eleven treatments {T_1: Paddy straw mulching @15 tons ha -1 after sowing, T_2: Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE) +Paddy straw mulching @15 tons/ ha after sowing, T_3: Black polythene mulch 30 micron, T_4: Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE) + 1 hand weeding 30 DAP, T_5 Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE) + 1 hand weeding, 30 DAP+ Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE), T_6: Imazethapyr 10 SL @ 0.10 kg a.i. ha^{-1} at 20 DAP (PoE), T_7: Imazethapyr 10 SL @ 0.10 kg a.i. ha^{-1} at 20 DAP (PoE) and 40 DAP, T_8: 2,4-D amine salt 58% SL @ 1.0 kg a. i. ha^{-1} (PoE) + Quizalofop Ethyl 5 EC @ 0.05 kg a.i. ha^{-1} at 20 DAP (PoE), T $_9$: 2,4-D amine salt 58% SL @ 1.0 kg a. i. ha^{-1} (PoE) + Quizalofop Ethyl 5 EC @ 0.05 kg a.i. ha^{-1} at 20 DAP (PoE) and 40 DAP (PoE), T_{10}: Two Hand Weeding at 30 and 60 DAP and T_{11}: Unweeded (Control) with three replications.

Result and Discussion

Plant height (cm)

The plant height was observed at different plant growth stages (30, 60 and 90 DAP). The gladiolus plant height was significantly influenced by various methods of weed management during the experiment duration. At 30 DAP, significantly the maximum plant height (40.47 cm) was noted with treatment T_5 {Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE) + 1 hand weeding 30 DAP + Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE)}, which was found statistically similar with treatment T_2, treatment T_3 and treatment T_4. While, the minimum plant height (24.36 cm) was observed with treatment T_{11} Unweeded (Control). At 60 DAP, significantly maximum plant height (45.73 cm) of gladiolus was noted with treatment T_5 {Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE) + 1 hand weeding 30 DAP + Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE)}, which was statistically similar with treatment T_1, treatment T_2, treatment T_3, treatment T_4 and treatment T_6. Whereas, the lowest plant height (28.53 cm) was noted in treatment T_{11} Unweeded (Control). Similarly at 90 DAP, significantly maximum plant height (65.14 cm) was observed in treatment T_5 {Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE) + 1 hand weeding 30 DAP + Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE), but it was *at par* to treatments T_1, T_2, T_3 and T_4 . While, the lowest plant height (42.52 cm) was observed with treatment T_{11} Unweeded (Control).

Number of leaves per plant

The number of leaves per plant in gladiolus was significantly influenced by different weed management techniques at 30, 60 and 90 DAP, as shown in Table 1.

At 30 DAP, significantly maximum number of leaves (6.27) per plant was noted with treatment T_5 {Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE) + 1 hand weeding 30 DAP + Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE)} which found was statistically similar with treatment T_2, treatment T_3 and treatment T_4. While, significantly the lowest number of leaves (1.82) per plant was observed in treatment T_{11} Unweeded (Control). Similarly at 60 DAP, significantly highest number of leaves (10.22) per plant was noted with treatment T_5 {Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE) + 1 hand weeding 30 DAP + Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE)}, but it was *at par* to treatments T_1, T_2, T_3 and T_4. However, the minimum number of leaves (3.32) per plant was noticed with treatment T_{11} Unweeded (Control). At 90 DAP, significantly more number of leaves (12.34) plant^{-1} was noted in treatment T_5 {Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE) + 1 hand weeding 30 DAP + Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE)} as compare to rest of the other treatments, but it was statistically similar with treatments T_1, T_2, T_3, T_4, T_6 and T_{10} . While, the lowest number of leaves (5.57) per plant was noticed with treatment T_{11} Unweeded (Control).

Number of shoots per plant

The data on number of shoots per plant was observed and displayed in Table 2 Various methods of weed management as significantly influenced on number of shoots per plant during the investigation.

The significantly maximum number of shoots (2.89) per plant was noted with treatment T_5 {Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE) + 1 hand weeding 30 DAP + Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE)} which was statistically similar with treatment T_4, treatment T_2, treatment T_3, treatment T_1 and treatment T_{10}. While, significantly lowest number of shoots (1.28) per plant was observed with treatment T_{11} Unweeded (Control).

The significantly highest plant height of gladiolus, number of leaves and number of shoots per plant in gladiolus were observed with treatment T_5. The reason for maximum plant height, number of leaves and number of shoots plant^{-1} may be due to effective weed management (application of pre-emergence herbicide Pendimethalin 30% EC with 1 hand weeding) may have reduces the weed flora and also improved the gladiolus crop's ability to optimum use nutrients, soil moisture, carbon dioxide and light to construct new plant tissues, resulting in improved plant height, number of leaves and shoots per plant. The decrease in the above the different growth parameters in unweeded (control). It's possible that this is due to a lack of sufficient nutrients, space and moisture for the plant's luxuriant growth at vital periods. The present study confirms with conclusion of Bhat *et al.* (2013) [3] in gladiolus, Jeevan *et al.* (2016) [5] in tuberose cv. Hyderabad Single and Swaroop *et al.* (2017) in gladiolus.

Days taken to 50% spike initiation

It is clear from the data present in Table 2. That there was significant difference in the days taken to 50% spike initiation in gladiolus due to application of different weed management practices.

The significantly minimum (60.21 days) days taken to 50% spike initiation was recorded in treatment T_5 {Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE) + 1 hand weeding 30 DAP + Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE)}, but it was *at par* to treatment T_4, treatment T_2, treatment T_3 and treatment T_{10}. The treatment T_{11} Unweeded (Control) was observed significantly maximum days (78.81 days) taken to 50% spike initiation of gladiolus.

Days taken for 50% flowering

The significantly the minimum (71.84) days taken to 50% flowering was recorded in treatment T_5 {Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE) + 1 hand weeding 30 DAP + Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE)}, which was *at par* with treatments T_4, T_2, T_3, T_1, T_7 and T_{10}. While, the maximum (95.18) days taken to flowering in treatments T_{11} Unweeded (Control).

Days taken for 50% spike initiation and 50% flowering in gladiolus was observed under treatment T_5 might be due to

decreased weed population, particularly during critical periods of crop-weed competition growth, resulting in more photosynthetic output and translocation are adequate to meet sink needs. Similar result was found by Rao *et al.* (2014) [10] in gladiolus, Rathod and Venugopal (2017) [9] in tuberose.

Number of spikes per plant

The data regarding number of spikes per plant as significantly influenced by various methods of weed management and data are resented in Table 3.

The treatment T_5 {Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE) + 1 hand weeding 30 DAP + Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE)} recorded significantly maximum number of spikes (3.00) per plant which was statistically similar with treatment T_4, treatment T_2, treatment T_3 and treatment T_1. However, the minimum number (1.00) of spikes per plant was noted with treatment T_{11} Unweeded (Control).

Spike length (cm)

Table 3 show data on gladiolus spike length (cm) as a significantly influenced various weed management treatments in gladiolus.

Among the various treatments, treatment T_5 {Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE) + 1 hand weeding 30 DAP + Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE)} registered significantly maximum spike length (59.67 cm) which was found *at par* with treatment T_4, treatment T_2, treatment T_3, treatment T_1 and treatment T_{10}. While, the lowest spike length (43.21cm) was recorded in the treatment T_{11} Unweeded (Control).

Number of florets per spike

The data regarding number of florets spike^1 as significantly influenced by various weed management methods in gladiolus and data are shown in Table 3.

The treatment T_5 (Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE) +1 hand weeding 30 DAP + Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE) was observed significantly maximum number of florets (12.13) spike^1, but it was statistically similar with treatment T_4, treatment T_2, treatment T_3, treatment T_1 and treatment T_{10}. Whereas, the minimum number of florets (7.17) spike^1 was recorded in the treatment T_{11} Unweeded (Control).

Floret basal diameter (cm)

The data regarding basal floret diameter as significantly influenced by various treatments of weed management practices in gladiolus and data are shown in Table 3.

The treatment T_5 {Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE) + 1 hand weeding 30 DAP + Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE)} noticed significantly maximum basal floret diameter (12.67 cm) which was *at par* with treatment T_4, treatment T_2, treatment T_3, treatment T_1 and treatment T_{10}. The minimum basal floret diameter (8.43 cm) was recorded in the treatment T_{11} Unweeded (Control).

This could be explained by the fact that pendimenthlin, which works by attaching to the plasto-quinone binding protein in photosynthesis II, may have caused relative weeds to die from malnutrition and oxidative damage induced by a breakdown in the electron transport pathway. As a result of lower weed density, there was comparatively less competition of the crop from weeds for nutrients, space, soil moisture and sun light, which may have resulted in higher photosynthetic activity and accumulation of more food material, resulting in increases in the number of spikes per plant, spike length, number of florets per spike and floret diameter. Also similar result found by Rao *et al.* (2014) [10] in gladiolus, Ali *et al.* (2015) [1] in gladiolus.

Table 1: Impact of different methods of weed management on plant height (cm) and number of leaves per plant in gladiolus

	Treatment	Plant height (cm)			Number of leaves per plant		
		30 DAP	60 DAP	90 DAP	30 DAP	60 DAP	90 DAP
T_1	Paddy straw mulching @15 tons ha^{-1} after sowing	34.18	42.84	56.13	4.18	7.30	9.58
T_2	Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1}(PE) +Paddy straw mulching @15 tons/ ha after sowing	37.27	43.53	60.45	5.20	8.72	10.93
T_3	Black polythene mulch 30 micron	36.27	43.40	58.31	4.72	8.27	10.15
T_4	Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1}(PE) + 1 hand weeding 30 DAP	38.40	44.29	62.80	5.45	9.44	11.28
T_5	Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1}(PE) + 1 hand weeding 30 DAP + Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1}(PE)	40.47	45.73	65.14	6.27	10.22	12.34
T_6	Imazethapyr 10 SL @ 0.10 kg a.i. ha^{-1} at 20 DAP (PoE)	33.57	42.47	53.62	3.68	6.40	8.70
T_7	Imazethapyr 10 SL @ 0.10 kg a.i. ha^{-1} at 20 DAP (PoE) and 40 DAP	28.30	30.07	44.69	2.52	3.97	6.38
T_8	2,4-D amine salt 58% SL @ 1.0 kg a. i.ha^{-1} (PoE) + Quizalofop Ethyl 5 EC @ 0.05 kg a.i.ha^{-1} at 20 DAP (PoE)	29.31	36.53	47.39	2.77	4.40	6.58
T_9	2,4-D amine salt 58% SL @ 1.0 kg a. i.ha^{-1} (PoE) + Quizalofop Ethyl 5 EC @ 0.05 kg a.i.ha^{-1} at 20 DAP (PoE) and 40 DAP (PoE)	30.85	37.00	49.37	3.23	5.45	7.38
T_{10}	Two Hand Weeding at 30 and 60 DAP	32.32	38.33	51.53	3.48	6.10	8.25
T_{11}	Unweeded (Control)	24.36	28.53	42.52	1.82	3.32	5.57
	S.Em ±	1.88	2.47	3.51	0.61	1.06	1.44
	CD (P=0.05)	5.54	7.30	10.35	1.81	3.14	4.27

Table 2: Impact of different methods of weed management on number of shoots per plant, days taken to 50% spike initiation and 50% flowering of gladiolus

Treatment	Number of shoots per plant	Days taken to 50% spike initiation	Days taken to 50% flowering
T_1	2.45	68.47	81.11
T_2	2.68	64.30	76.52
T_3	2.50	66.52	78.70
T_4	2.70	62.26	74.36

T_5	2.89	60.21	71.84
T_6	1.98	75.54	83.43
T_7	1.57	72.47	92.50
T_8	1.67	75.70	90.30
T_9	1.77	73.33	88.04
T_{10}	2.40	70.24	85.52
T_{11}	1.28	78.41	95.18
S.Em ±	0.18	3.80	4.94
CD (P=0.05)	0.52	11.21	14.59

Table 3: Impact of different methods of weed management on number of spikes per plant, spike length (cm), number of florets spike[1] and floret diameter (cm) of gladiolus

Treatment	Number of spikes per plant	Spike length (cm)	Number of florets spike[1]	Floret diameter (cm)
T_1	2.40	54.23	10.16	10.80
T_2	2.80	54.53	11.03	10.93
T_3	2.60	55.47	10.23	10.87
T_4	2.93	57.88	11.63	11.06
T_5	3.00	59.67	12.13	12.67
T_6	2.27	49.33	7.27	9.20
T_7	1.30	47.9	9.03	9.87
T_8	1.50	46.07	7.77	9.43
T_9	1.85	47.3	7.90	9.90
T_{10}	2.07	53.53	10.13	10.57
T_{11}	1.00	43.21	7.17	8.43
S.Em ±	0.22	2.37	0.69	0.71
CD (P=0.05)	0.64	6.98	2.03	2.11

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