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Flowering and Corm Yield of Gladiolus cv. Jyotsna as Influenced by Pre-emergence Application of Different Herbicides

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ABSTRACT: *A field experiment was conducted for two years (2011-12 & 2012-13) during winter season, at the Research Farm of the Division of Floriculture and Landscaping, Indian Agricultural Research Institute, New Delhi to study the Weed flora, flowering and corm yield of gladiolus cv. Jyotsna as influenced by pre-emergence application of different chemical herbicides. The experiment was laid out in randomized complete block design with ten treatments and replicated thrice. Row to row and plant to plant distance was maintained as 50 x 20 cm in a plot size of 2.0 m x 2.0 m. A critical examination of two years data indicated that all the herbicides treatments resulted in lower weed density i.e. dry weight, number of monocot as well as dicot weeds than the weedy check. Further, results showed that maximum dry weight of weeds (170.9 g/m^2), number of monocot weeds (165.0/m^2) and number of dicot weeds (364.3/m^2) were recorded in weedy check treatment. Amongst all the treatments, application of Pendimethalin 0.75 lit./ha + Metribuzin 0.3 kg/ha (T_5) treatment was found the best which recorded maximum plant height (116.3 cm), yield of corm (43.9 q/ha) , net profit (Rs. 4,16,573.00) as compared to control and other treatments. The next second best treatment was (T_6) i.e. application of Atrazine @ 1.0 kg/ha + residues 5.0 tonnes/ha in terms of dry weight of monocot and dicot weed, florets opened at a time. Thus, it is concluded that herbicide chemicals combined together are more effective than alone. The highest yield of corms as well as maximum economic returns in gladiolus cv. Jyotsna were obtained with pre- emergence application of Pendimethalin @ 0.75 lit./ha + Metribuzin @ 0.3 kg/ha, besides obtaining broad spectrum weed control throughout the crop growth period. and present experiment also indicated that application of herbicide i.e. Atrazine 1.0 kg/ha pre-emergence + residues 5 tonnes/ha was found to be the most effective in minimizing density of weeds.*

INTRODUCTION

Gladiolus (*Gladiolus hybridus* Hort.) is one of the most important ornamentals for cut flower trade in India and abroad. It is also ideal for garden display, floral arrangements for table and interior decoration as well as making high quality bouquet (Lepcha *et al., 2007).* It is popular for its attractive spikes having florets of huge form, dazzling colours varying sizes and long keeping quality. Gladiolus as cut flower is increasing day by day in domestic as well as international markets. In recent years, several new cultivars of gladiolus with wide range of colours have been developed for marketing. Weed competition is one of the major biotic constraints in realizing higher productivity. Control of weeds is important to reduce the weed competition as well as to maximize the efficient utilization of resources to raise the productivity of the crop, because emergence and rapid growth of weed leads to severe weed- crop competition for light, moisture, space and nutrients, at the same time, its yield is reduced up to 50-100 percent (Mehta *et al.*, 2010 and Rao *et al.*, 2007). Weed is an important factor responsible for loss in crop production (Meena *et al.*, 2013). Pre- emergence herbicides may be viable option to control the weeds right from the sowing to harvesting of any crop (Sankar and Subramaniam, 2011). Herbicides are considered to be an economical alternative to manage weeds against age old practice of hand weeding, which is more costly and also becomes impracticable due to non availability of labourers during peak period of weeding and it makes gladiolus production less remunerative. Precise information on weed management in gladiolus is essential and inevitable for getting growth of plants. Therefore, the present

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experiment was undertaken to evaluate the comparative performance of herbicides alone and in combination on growth, flowering, yield and weed control of gladiolus cv. Jyotsna.

MATERIALS AND METHODS

A field experiment was conducted for two years (2011-12 & 2012-13) during winter season at the Research Farm of the Division of Floriculture and Landscaping, Indian Agricultural Research Institute, New Delhi. The soil was sandy clay loam with pH 7.0-7.5. It was moderately fertile, being low in available organic carbon (0.48%), available N (138.00 kg/ha), P (30.50 kg/ha) and K (187.90 kg/ha). The experiment was planted on 15th November in 2011 and 17th November in 2012 which laid out in randomized complete block design with ten treatments and replicated thrice. Row to row distance 50 cm and plant to plant 20 cm was maintained in a plot size of 2.0 m x 2.0 m. The weed control treatments imposed are: T_1 (Atrazine @1.0 kg/ha pre-emergence), T_2 (Pendimethalin @1.0 lit./ha pre-emergence), T_3 (Metribuzin 0.5 kg/ha pre-emergence), T_4 (Atrazine 0.75 kg/ha +Pendimethalin 0.75 lit./ha pre emergence), T_5 (Pendimethalin 0.75 lit./ha + Metribuzin 0.3 kg/ha pre emergence), T_6 (Atrazine @1.0 kg/ha pre-emergence + residues 5.0 tonnes/ha), T_7 (Atrazine @1.0 kg/ha pre-emergence + one hand weeding 30 DAP), T_8 (Butachlor 1.0 lit./ha pre emergence), T_9 (Weed- free check), T_{10} (Weedy check). Hand weeding and weedy check treatments were kept for comparison with weedicides treatments. A uniform dose of 120 kg N, 80 kg P_2O_5, and 80 kg K_2O/ha was applied. Half dose of N and whole of P and K were applied as basal before planting. Remaining half dose of N was top-dressed at 45 days after planting. These fertilizers were applied in the form of urea, single superphosphate and muriate of potash. Uniform size of gladiolus corms (4.0- 5.0 cm), cv. Jyotsna were planted on 15.11.2011 and 17.11.12. The pre-emergence (just after planting) herbicides were applied with the help of a hand operated knapsack sprayer fitted with flat-fan nozzle. The data for weed density, weed counting, fresh and dry weight of weed were collected at 30 and 60 days after planting, while other growth, flowering, yield and corms attributes were collected at their appropriate time. Weed observations were recorded twice at 30 and 60 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 dominant weed species present in the experimental field were dicot and monocot such as *Convolvulus arvensis, Coronopus didymus, Parthenium hystophorus, Chenopodium murale, Trianthema portulaka, Cyperus rotundus* and *Cynodon dactylon* respectively. Mean of two years data presented in Table 1 and 2 indicated that all the herbicides treatment resulted in lower weed density i. e. dry weight, number of monocot as well as dicot weeds than the weedy check. Treatment (T_5) had taken minimum days (12.1) to sprouting while it was maximum (14.1 day) in control treatment. Maximum sprouting percent (96.7) was recorded by treatment (T_4) i.e. application of Pendimethalin @0.75 litre + Atrazine 0.75 kg/ha, followed by treatment T_1 and $T_{10,}$ whereas, minimum sprouting 93.4 percent was recorded in treatment (T_2) i.e application of Pendimethalin @ 1.0 litre /ha after 60 days of planting. Treatment i.e weed free check (T_9) was significantly found to be superior over others in respect to first floret opening (98 day) whereas treatment (T_2) had taken more days (101.7) as compared to other treatments. Further, the results showed that maximum dry weight of monocot and dicot weeds was recorded (170.9 g/m^2) in control treatment (T_{10}), whereas, it was minimum (2.5 g/m^2) in treatment (T_6) followed by treatments T_1 , T_4 and T_5 respectively. It was observed in general that monocot and dicot weed population was more in control treatment and the two years mean data indicated that Treatment (T_{10}) had recorded 165.0 and 364.3 number of monocot and dicot weed respectively. The minimum number of monocot weed (4.0) was observed in treatment (T_6) with the application of Atrazine @ 1.0 kg/ha +residues 5.0 tonnes/ha, followed by treatment (T4) which had recorded 4.3 monocot weed. In case of dicot weed, it was minimum (0.8) in treatment (T_4), followed by treatments T_1 and T_3 which were at par (Table 2). The combined application of Atrazine 1.0 kg/ha pre-emergence + 5 tonnes/ha residues (T_6) and Atrazine + Pendimethalin alone and with combination also effectively controlled both the narrow and broad-leaved weeds, mainly monocot and dicot weeds. In control treatment, occurrence of more number of weed species, higher density/unit area and favourable growing conditions turning crop-weed competition in favour of weeds, resulted in increase in dry weight of weeds and also number of monocot and dicot weeds. The results are in agreement with findings of Mandhata Singh and R.P. Singh (2010). Better control of weeds by pre-emergence herbicides in early stages was also

Table 1
Effect of Different Chemical Herbicides on Days to Sprout, Sprouting Percentage and Days to First Floret Opening in gladiolus cv. Jyotsna

Treatments	*Days to sprouting*			*Sprouting % (60 DAP)*			*Days to first floret opening*		
	2011-12	*2012-13*	*Mean*	*2011-12*	*2012-13*	*Mean*	*2011-12*	*2012-13*	*Mean*
T_1, Atrazine 1.0 kg/ha pre-emergence	12.7	12.3	12.5	95.0	97.3	96.2	100.0	102.7	101.3
T_2 , Pendimethalin @1.0 lit./ha pre-emergence	13.3	13.0	13.1	90.9	96.0	93.4	101.0	102.3	101.7
T_3, Metribuzin 0.5 kg/ha pre-emergence	13.0	13.1	13.0	94.2	95.3	94.7	101.0	100.3	100.7
T_4 , Atrazine 0.75 kg/ha + Pendimethalin 0.75 lit./ha	13.3	13.6	13.4	97.5	96.0	96.7	100.0	102.0	101.0
T_5, Pendimethalin 0.75 lit./ha + Metribuzin 0.3 kg/ha pre emergence	12.0	12.3	12.1	95.8	95.3	95.6	99.0	97.3	98.2
T_6, Atrazine @1.0 kg/ha pre-emergence + residues 5.0 tonnes/ha	13.7	13.8	13.7	96.7	93.3	95.0	100.5	101.3	100.9
T_7, Atrazine @1.0 kg/ha pre-emergence + one hand weeding 30 DAP	13.3	13.0	13.1	95.8	95.3	95.6	101.0	101.0	101.0
T_8, Butachlor 1.0 lit./ha pre emergence	13.0	13.3	13.1	97.5	94.7	96.1	100.0	100.3	100.2
T_9, Weed- free check	12.7	12.6	12.6	97.5	92.0	94.8	98.00	98.00	98.0
T_{10}, Weedy check	14.3	14.0	14.1	98.3	94.0	96.2	100.0	97.7	98.8
C D at 5%	1.68	1.03		0.99	1.03		2.33	2.69	

Table 2
Effect of Different Chemical Herbicides on Dry Weight, Number of Monocot and Dicot Weeds in Gladiolus cv. Jyotsna

Treatments	*Dry weight of monocot and dicot weeds (g)*			*Number of monocot weeds*			*Number of dicot weeds*		
	2011-12	*2012-13*	*Mean*	*2011-12*	*2012-13*	*Mean*	*2011-12*	*2012-13*	*Mean*
T_1, Atrazine 1.0 kg/ha pre-emergence	3.5	2.5	3.0	5.0	4.0	4.5	2.4	1.0	1.7
T_2 , Pendimethalin @1.0 Lit./ ha pre-emergence	75.2	73.4	74.3	18.4	17.0	17.7	34.7	39.9	37.3
T_3, Metribuzin 0.5 kg/ha pre-emergence	4.2	3.10	3.6	8.7	9.3	9.0	1.0	2.3	1.7
T_4 , Atrazine 0.75 kg/ha + Pendimethalin 0.75 lit./ha	5.9	3.0	4.4	5.7	3.0	4.3	1.7	0.0	0.8
T_5, Pendimethalin 0.75 Lit./ha + Metribuzin 0.3 kg/ha pre emergence	6.9	6.0	6.4	10.4	13.0	11.7	7.0	5.0	6.0
T_6, Atrazine @1.0 kg/ha pre-emergence + residues 5.0 tonnes/ha	2.3	2.7	2.5	4.7	3.3	4.0	3.0	1.3	2.2
T_7, Atrazine @1.0 kg/ha pre-emergence + one hand weeding 30 DAP	16.9	14.9	15.9	11.3	14.3	12.8	107.7	102.0	104.8
T_8, Butachlor 1.0 lit./ha pre emergence	94.9	102.3	98.6	52.7	49.7	51.2	190.4	214.0	202.2
T_9, Weed- free check	8.3	9.6	8.9	22.0	21.0	21.5	12.0	18.0	15.0
T_{10}, Weedy check	173.4	168.4	170.9	164.0	166.0	165.0	374.3	354.3	364.3
C D at 5%	4.58	0.64		5.05	1.18		17.65	0.94	

observed in almost all treatments except weedy check. Higher weed population and dry weight results in more competition for growth resources causing stunted growth of crop, thus plant height was reduced significantly during both the years in control treatment as compared to other treatments and it was recorded minimum (91.0 cm), whereas, maximum plant height (116.3 cm) was recorded with the application of Pendimethalin @0.75 litre/ha + Metribuzin @0.3 kg/ha(T_5).

A perusal of data (Table 3 and 4) revealed that spike and rachis length, florets per spike and corm

Table 3
Effect of Different Chemical Herbicides on Plant Height, Spike and Rachis Length of Gladiolus cv. Jyotsna

Treatments	*Plant height (cm)*			*Spike length (cm)*			*Rachis length (cm)*		
	2011-12	*2012-13*	*Mean*	*2011-12*	*2012-13*	*Mean*	*2011-12*	*2012-13*	*Mean*
T_1, Atrazine 1.0 kg/ha pre-emergence	105.0	97.7	101.3	85.3	79.3	82.3	57.3	48.7	52.9
T_2 , Pendimethalin @1.0 lit./ ha pre-emergence	118.7	104.0	111.0	89.3	88.3	88.8	61.0	65.3	63.2
T_3, Metribuzin 0.5 kg/ha pre-emergence	111.3	99.0	105.2	88.3	87.0	88.2	58.3	48.0	53.2
T_4 , Atrazine 0.75 kg/ha + Pendimethalin 0.75 lit./ha	101.7	103.3	102.5	87.7	86.3	86.9	64.0	54.3	59.2
T_5, Pendimethalin 0.75 lit./ha + Metribuzin 0.3 kg/ha pre emergence	123.0	109.7	116.3	91.7	90.0	90.8	70.0	54.7	62.3
T_6, Atrazine @1.0 kg/ha pre-emergence + residues 5.0 tonnes/ha	119.0	93.0	106.0	91.0	86.0	88.5	63.7	54.7	59.2
T_7, Atrazine @1.0 kg/ha pre-emergence + one hand weeding 30 DAP	108.3	87.7	97.9	76.3	77.3	76.8	50.3	50.7	50.5
T_8, Butachlor 1.0 lit./ha pre emergence	107.7	100.0	10.3.9	84.0	77.0	80.5	54.7	48.3	51.5
T_9, Weed- free check	116.3	106.7	111.5	94.0	89.7	91.8	66.0	64.7	65.3
T_{10}, Weedy check	97.0	85.0	91.0	75.0	65.7	70.3	43.0	40.4	41.7
C D at 5%	2.82	3.29		1.71	2.51		0.24	1.92	

Table 4
Effect of Different Chemical Herbicides on Quantitative Characters of Gladiolus cv. Jyotsna

Treatments	*Number of florets per spike*			*Florets opened at a time*			*Number of corms per plant*		
	2011-12	*2012-13*	*Mean*	*2011-12*	*2012-13*	*Mean*	*2011-12*	*2012-13*	*Mean*
T_1, Atrazine 1.0 kg/ha pre-emergence	16.7	15.7	16.2	4.7	6.0	5.3	3.0	3.0	3.0
T_2 , Pendimethalin @1.0 lit./ha pre-emergence	17.7	16.0	16.8	6.0	6.7	6.3	4.0	3.3	3.7
T_3, Metribuzin 0.5 kg/ha pre-emergence	17.3	17.3	17.3	7.3	6.3	6.8	2.0	3.0	2.5
T_4 , Atrazine 0.75 kg/ha + Pendimethalin 0.75 lit./ha	16.7	14.7	15.7	6.7	5.7	6.2	3.0	3.3	3.2
T_5, Pendimethalin 0.75 lit./ha + Metribuzin 0.3 kg/ha pre emergence	17.7	16.3	17.0	7.3	6.3	6.8	2.0	3.7	2.8
T_6, Atrazine @1.0 kg/ha pre-emergence + residues 5.0 tonnes/ha	17.3	16.3	16.8	7.0	7.0	7.0	3.0	2.7	2.8
T_7, Atrazine @1.0 kg/ha pre-emergence + one hand weeding 30 DAP	15.0	14.7	14.8	7.3	4.3	5.8	3.0	2.3	2.7
T_8, Butachlor 1.0 lit./ha pre emergence	15.0	13.0	14.0	6.0	6.0	6.0	2.3	2.3	2.3
T_9, Weed- free check	18.3	17.7	18.0	6.3	6.3	6.3	2.3	3.0	2.7
T_{10}, Weedy check	14.7	13.0	13.8	6.3	4.3	5.3	2.3	2.0	2.2
C D at 5%	1.75	1.66		0.79	NS		0.54	NS	

per plant of gladiolus were significantly affected by different treatments. Amongst all the treatments, treatment(T_9) weed free check was found to be best which recorded maximum spike and rachis length (91.8 and 65.3 cm) respectively as compared to weedy check and other treatments. Other second best treatments were (T_9 and T_2) which had recorded 90.8 and 63.2 cm spike and rachis length respectively. Maximum florets per spike (18.0) was also produced by treatment (T_9) followed by treatment (T_3) and (T_5) whereas; it was minimum (13.8) florets per spike in control treatment. More number of florets (7.0) was remaining open at time in treatment (T_6). Application of Pendimethalin @ 1.0 litre/ha(T_2) and combination of Atrazine + Pendimethalin (T_4) had produced (3.7 and 3.2) corms per plant respectively; whereas in control treatment, it was 2.2 corms per plant. The two years mean yield of corms indicated that application

of Pendimethalin @ 0.75 litre/ha + Metribuzin @ 0.3 kg/ha pre- emergence (T_5) had increased sizable corms yield (43.0 q/ha) followed by treatment (T_2 and T_3) which had produced (34.0 and 31.0 q/ha) corms respectively, as compared to control (14.9 q/ha). It is very clear to note that all the herbicides have improved the spike and corm yield and the maximum yield loss was when the weeds were totally left uncontrolled. There was no any harmful effect of herbicides on growth, flowering yield characters of gladiolus. These findings are in accordance with those of R.P. Singh (1993). These herbicides showed greater effect in increasing the weed control efficiency. The results can be attributed due to marked improvement for minimizing crop-weed competition and better weed control efficiency. The minimum value of growth and flowering characters was recorded under weedy check which was attributed due to more weed growth, dry weight and poor corm yield. These results are in agreement with the findings of Chinnasamy *et al*, (2005) and Mohan *et al*, (2005). The best treatment of herbicides under (T_6) might be due to emergence weeds in short span in which most of the weeds were affected by herbicides. This fact is well documented by Vaishya and Tomer (2000). The poor effect of herbicides under weedy check was owing to extended period of weed emergence as it provided better environment for emergence of weeds.

The economic analysis revealed highest monetary advantage in terms of gross, net returns and benefit cost ratio with treatment (T_5) i.e. Pendimethalin 0.75 lit./ha + Metribuzin 0.3 kg/ha. The next best treatment was Rs. 2,70,520/= net profit with (T_2) Pendimethalin @ 1.0 lit./ha, followed by treatment (T_4) Attrazine 0.75 kg/ha + Pendimethalin 0.75 lit./ha. These herbicides gave more net returns than other treatment combinations and weedy check. Two years mean data also indicated that weed free check treatment (T_9) was more expensive than other treatments as the more labourers were involved for weeding the plot frequently (Table 5).

CONCLUSION

Thus, it is inferred from the investigation and concluded that pre-emergence application of herbicides combined together are more effective than alone. The highest corms yield and spikes as well as maximum economic returns in gladiolus cv. Jyotsna were obtained with pre- emergence application of Pendimethalin @ 0.75 lit./ha + Metribuzin @ 0.3 kg/ha, besides obtaining broad spectrum weed control throughout the crop growth period.

Table 5
Effect of Different Chemical Herbicides on Corms Yield, Net Profit and Benefit Cost Ratio of Gladiolus cv. Jyotsna

Treatments	*Yield of corms (q/ha)*			*Total gross income, Rs/ha (mean of two years)*	*Total cost of production Rs/ha (mean of two years)*	*Net profit Rs/ha (mean of two years)*	*Benefit cost ratio (mean of two years)*
	2011-12	*2012-13*	*Mean*				
T_1, Atrazine 1.0 kg/ha pre-emergence	22.1	20.9	21.5	6,08,750.0	4,76,870.0	1,31,880.0	1:1.27
T_2 , Pendimethalin @1.0 lit./ha pre-emergence	32.1	35.9	34.0	7,47,500.0	4,76,980.0	2,70,520.0	1:1.56
T_3, Metribuzin 0.5 kg/ha pre-emergence	29.5	32.5	31.0	7,22,500.0	4,77,573.0	2,44,927.0	1:1.56
T_4 , Atrazine 0.75 kg/ha + Pendimethalin 0.75 lit./ha	29.9	30.7	30.3	7,45,000.0	4,77,615.0	2,67,385.0	1:1.55
T_5, Pendimethalin 0.75 lit./ha + Metribuzin 0.3 kg/ha pre emergence	42.0	45.9	43.9	8,93,750.0	4,77,177.0	4,16,573.0	1:1.87
T_6, Atrazine @1.0 kg/ha pre-emergence + residues 5.0 tonnes/ha	28.1	29.6	28.9	6,81,250.0	4,77,100.0	2,04,150.0	1:1.42
T_7, Atrazine @1.0 kg/ha pre-emergence + one hand weeding 30 DAP	23.5	24.6	24.1	6,63,750.0	4,79,270.0	1,84,480.0	1:1.38
T_8, Butachlor 1.0 lit./ha pre emergence	22.7	21.8	22.3	5,88,774.0	4,76,820.0	1,11,954.0	1:1.23
T_9, Weed- free check	29.2	29.0	29.1	7,35,000.0	4,83,800.0	2,51,200.0	1:1.51
T_{10}, Weedy check	15.9	13.7	14.9	5,48,750.0	4,76,600.0	72,150.0	1:1.15
C D at 5%	1.67	4.45					

RFERENCES

Chinnusamy, C., M. K. Prabhakaran, and R. Shamughansundaram, (2006), Sequential herbicidal weed management in transplanted rice (*Oryza sativa* L.) Extended Summaries, Golden Jubilee National Symposium on Conservation Agriculture and Environment, held during 26-28 October,2006 at Banaras Hindu University, Varanasi, *Indian Society of Agronomy,* Abstract: pp. 317-8.

Mandhata, Singh and R. P. Singh, (2010), Efficacy of herbicides under different methods of direct-seeded rice (*Oryza sativa L.*) establishments. *Indian Journal of Agricultural Sciences*, 80(9): 815-9.

Lepcha, B., M. C. Nautiyal and V. K. Rao, (2007), Variability studies in gladiolus under Hill conditions of Uttarakhand. *Journal of Ornamental Horticulture*, 10(3): 169-172.

Mehta, R. S., B. S. Patel, and S. S. Meena, (2010), Weed dynamics and yield of Fenugreek (*Trigonella foenum-graecum*) as influenced with irrigation levels and weed management practices. *Indian Journal Agricultural Sciences*, 80(11): 970-974.

Meena, S. S., R. S. Mehta, G. Lal, and M. M. Anwer, (2013), Economic feasibility of weed management practices in fenugreek. *Indian Journal of Horticulture*, 70 (1): 150-153.

Mohan, K. S., T. V. Muniyappa and H. R. Shiva Kumar, (2005), Effect of pre-emergence herbicides on growth and yield of direct- seeded puddle rice (*Oryza sativa* L.). Extended Summaries, National Biennial Conference, held during 6-9 April, 2005 at PAU, Ludhiana, *Indian Society of Weed Science,* Abtsract, pp. 28-9.

Rao, A. N., D. E. Johnson, B. Sivaprasad, J. K. Ladha and A. M. Morfimer, (2007), Weed management in direct-seeded rice. *Advances in Agronomy*, 93: 153-255.

Vaishya, R. D. and S. K. Tomar, (2000), Weed control in puddle-seeded rice (*Oryza sativa* L.) with herbicides. *Indian Journal of Agronomy*, 45 (2): 334-7.

Sankar, K. Siva., and D. Subramanyum (2011), Weed Flora and yield of Sunflower (*Helianthus annuus* L.) as influenced by pre- and post- emergence application of herbicides. *Indian Journal of Weed Sci*. 43(1&2): 105-109.

Singh, R. P. (1993), Role of non-cash inputs in weed management. Proceedings of International Symposium, *Indian Society of Weed Science*, 1: 351-357.