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Weed management studies in tuberose (*Polianthes tuberosa* L.) cv. Prajwal

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Abstract: One of the main constraints in the commercial cultivation of crops is weeds. Flower crops especially tuberose, a vertical growing, non spreading one still gets tougher competition by weeds. Weeds cause irreparable damage to crops by competing for water, nutrients, light and space, besides acting as alternate hosts to a number of pathogens and insect pests. Manual weeding is time consuming and costly hence, chemical weed control is one of the alternative methods to control weeds. In the present study, weed management in tuberose cv. Prajwal by chemicals was undertaken. Higher leaf area was recorded in weed free check treatment (64.99cm^2), followed by pendimethalin 30 EC @ 1kg a.i./ha (63.59cm^2) and alachlor 50EC @ 1.5kg a.i/ha (61.69cm^2). The least number of days (94.00) were taken for first flowering under the weed free check treatment followed by pendimethalin 30EC @ 1kg a.i/ha (97.66days) and alachlor 50EC @ 1.5kga.i/ha (101.33 days). Among the different weed control treatments, under weed free check, maximum spike length of 84.18 cm was recorded which was statistically superior over rest of the treatments. Pendimethalin 30EC @ 1kg a.i/ha and alachlor 50EC @1.5kg a.i./ha were the next best which recorded the spike length of 81.22 and 80.85cm, respectively. The flower yield (t/ha) varied significantly (2.91 to 4.18 t/ha) among different treatments. The maximum flower yield was recorded in treatment weed free check (4.18t/ha, followed by pendimethalin 30EC @ 1 kg a.i./ha (3.67t/ha) and alachlor 50EC @ 1.5kg a.i/ha (3.54t/ha).

Key words: Growth, Herbicide, Tuberose, Weed parameters, Yield

Introduction

Traditional agriculture with regular cereal and pulse crops production is facing many constraints like increased cost of production and stagnated price for produce. Commercial horticulture is gaining importance because of WTO (World Trade Organization) agreement on export, processing and value addition. In modern society every function is incomplete without flower or decoration. In this context, loose flowers and especially, cut flowers are gaining importance because of their longer shelf-life and more aesthetic value. Tuberose (*Polianthes tuberosa* L.) is one of the popular and commercially important bulbous flower crops which belongs to family amaryllidaceae.

In India, tuberose is grown extensively in Karnataka, West Bengal, Andhra Pradesh, Tamil Nadu and Maharashtra. In Karnataka state during the year 2011-12, tuberose was grown in an area of 1789 ha with a production of 15811 tonnes (Anon., 2012). One of the main constraints in the commercial cultivation of flower crops is weeds. Weeds cause irreparable damage to crops by competing for water, nutrients, light and space, besides acting as alternate hosts to a number of pathogens and insect pests (Shalini and Patil, 2006). Manual weeding is time consuming and costly as the labour is scarce. Hence, it is imperative to employ alternative methods of weed control in tuberose cultivation irrespective of size of the holdings. Chemical weed control is one of the alternative methods of weed control in flower crops.

The science of weed control has advanced considerably during the past two decades. A number of herbicides have been advocated for control of weeds in flower crops. However detailed information on the suitable herbicides and effect of chemicals and their appropriate dosage, time of application is not fully available to the farmers use. Considering the economic importance of tuberose and above discussed points the present study was taken up to study the effect of pre and post emergent herbicides on growth and yield of tuberose cv. Prajwal.

Material and methods

The present field experiment on weed management in tuberose (*Polianthes tuberosa* L.) cv. Prajwal was conducted during 2014-15 at Medicinal and Aromatic Plants Block, Saidapur farm, University of Agricultural Sciences, Dharwad during *kharif* season. Dharwad lies between 15^o 26$^{'}$ N latitude and 75^o 07$^{'}$ E longitude in the Northern transitional zone (Zone 8) of Karnataka. The experiment was laid out in Random Complete Block Design (RCBD) with three replications. Totally eight treatment combinations were formed comprising weedicides namely, alachlor, pendimethalin and oxyfluorfen (pre-emergent) and three weedicides imazethapyr, oxyflourfen and pyrithiobac (post-emergent) which was sprayed once at 20 days after planting. Weedicide treatments were compared with weed free check where the weeds were removed manually.

The land was brought to fine tilth by ploughing and harrowing with tractor. A space of 0.50 m between two replications and 0.20 m between treatments were provided for irrigation channels. The well decomposed Farm Yard Manure @ 30 tonnes per hectare was applied to each plot at the time of planting and was well incorporated in the soil. In the experiment, the nutrients *viz.,* nitrogen, phosphorus and potassium were applied in the form of urea, diammonium phosphate (DAP) and muriate of potash (MOP), respectively. Fertilizers in basal dose and split doses were applied as per the recommended dose of 200:150:150 kg NPK per ha.

The uniform sized tuberose bulbs cv. Prajwal were used as planting material for the experiment. Bulb size of 2.0-2.5 cm was

used for planting. The bulbs were planted at 5 to 6 cm depth in the soil with spacing of 30 cm x 20 cm. Light irrigation was given after planting. Five plants were selected randomly for taking observations on growth and yield parameters in the net plot. Data were analysed statistically for test of significance following the fisher's method of Analysis of variance (ANOVA) as outlined by Sundararaj *et al.* (1972). The level of significance F- test was tested at 5 %. The interpretation of data was done by LSD value calculated at P=0.05.

Results and discussion

Data on weed population revealed that monocot weed population was least in the earlier stages and later on increased. At later stages, monocot weeds dominated over dicot weeds. Dicot weeds were less in number in the early stage of plant growth which may be attributed to staggered germination of seeds, shorter duration of weeds and crop inhibitory effect on weeds. Similar results were reported by Panwar *et al*. (2010) in tuberose cv. Double. With regard to the relative effectiveness of the herbicides tested, pendimethalin 30EC @ 1 kg a.i/ha and alachlor 50EC @ 1.5kg a.i/ha recorded the least monocot weed count while pyrithiobac 10EC @ 62.5g a.i/ha showed higher monocot weed count resulting in less effectiveness of the chemical against monocot weeds (Table 1). With regard to the relative effectiveness of the weed control treatments tested for controlling dicots, pendimethalin 30EC @ 1 kg a.i/ha, alachlor 50EC @ 1.5 kg a.i/ha, oxyfluorfen 23.5EC @ 74g a.i/ha and weed free check were effective in decreasing the dicot weed flora. These herbicides were effective in allowing the tuberose to have higher plant growth, early flowering and yield and hence decreased the dicot weed flora. Similar results were reported by Gaurav Sharma *et al*., 2014 in Chrysanthemum (*Dendranthema grandiflora* T.) under Chhattisgarh plains in which the aapplication of pendimethalin (extra) @ 0.64 kg ha^{-1}+one hand weeding at 40 DAT+pendimethalin (extra) @ 0.64 kg ha^{-1} at 45 DAT was found to suppress the weeds and resulted in higher growth and flowering parameters in chrysanthemum. Needless to say that the 100 per cent weed control efficiency in weed free check was because of the fact that the weeds were removed as and when they appeared or emerged. Among the herbicidal treatments, pendimethalin 30EC @ 1 kg a.i/ha and alachlor 50EC @ 1.5 kg a.i/ha recorded maximum weed control efficiency (Table 1). Lowest weed control efficiency was observed in pyrithiobac 10 EC @ 62.5 g a.i/ha is due to poor control of weeds.

Effect on vegetative and reproductive parameters

Vegetative growth in tuberose is measured best in terms of plant height, number of leaves, leaf area and dry weigh of plants. In the present study, tuberose crop responded positively to weed control treatments. Plant height did not vary significantly due to weed control treatment at 30 days after planting, however, significant difference in plant height among the weed control treatments was recorded at 60, 90 and 120 days after planting. Throughout the crop growth period the weed free treatment recorded maximum plant height at 30, 60, 90 and 120 days after planting (18.34, 22.64, 37.41 and 57.71cm, respectively) while it was on par with pendimethalin 30EC @ 1 kg a.i/ha (54.35 cm), alachlor 50EC @ 1.5 kg a.i/ha (55.30) and weed free check (57.71cm). This was due to better availability of nutrients, moisture and space for the crop growth and development by avoiding or reducing the crop weed competition throughout the crop growth. This is in conformity with the findings of Dhanumjaya Rao *et al*. (2014) in gladiolus who reported that pendimethalin at both concentrations (pendimethalin@ 0.75 kg a.i./ha and pendimethalin@ 1 kg a.i./ha) has resulted in significantly maximum plant height (91.20cm and 87.35cm, respectively) over weedy check (77.34cm) and at par with weed free check (88.67cm). The lowest plant height was recorded with weedy check. This was due to the fact that weed count was more in weedy check and resulting in severe competition by weeds with the crop for resources which made the crop to suffer and ultimately reduced the plant height (Table 1).

Leaf production was maximum in weed free check throughout the crop period, however it was minimum in weedy check. Among the weed control treatments, pendimethalin 30EC @ 1 kg a.i/ha, alachlor 50 EC @ 1.5 kg a.i/ha and weed free check treatments recorded maximum leaf production per plant (31.13, 30.46 and 34.33, respectively). This was due to the fact that these treatments reduced the weed competition with the crop and as a result the competition for nutrients, moisture and sunlight and resulted in better growth. On the other hand, due to severe competition of weeds with crop for water, nutrients and sunlight in weedy check plot the growth of crop was suppressed (Table 1). Leaf area is considered as one of the important physiological indices as it represents the size of photosynthetic system. Leaf area per plant differed significantly due to weed control treatments. Among the different treatments, weed free check throughout the crop period recorded the higher leaf area which was followed by pendimethalin 30EC @ 1 kg a.i/ha, alachlor 50EC @ 1.5 kg a.i/ha and oxyfluorfen 23.5 EC @ 75 g a.i/ha (PE). Similar observations of increased leaf area was obtained by Basavaraju (1989).

The dry weight of plant differed significantly due to weed control treatments. It was maximum in the weed free check throughout crop period. This was mainly due to the fact that there was no competition of weeds with the tuberose crop. Among different weed control treatments, weed free check, pendimethalin 30EC @ 1 kg a.i/ha and alachlor 50EC @ 1.5kg a.i/ha recorded higher values of dry weight of plant (13.18, 12.25 and 11.44g, respectively). This could be attributed to the lesser weed density in these treatments in turn increased dry matter of the tuberose plants. There was a marked difference in days taken for first flowering among the different weed control treatments. Weed free check closely followed by pendimethalin 30EC @ 1 kg a.i/ha and alachlor 50 EC @ 1.5 kg a.i/ha caused early flowering (94.00, 7.66 and 101.33 days, respectively). Weedy check plot was late to initiate flowering. This was obvious because of severe infestation of weeds which resulted in competition for moisture, nutrients and space. Similar result was also reported by Murthy and Gowda (1993) in tuberose.

Flower quality is best measured in term of spike length, length of rachis, number of florets per spike and flower diameter.

Table 1. Effect of different weed control treatments on weed parameters and crop growth parameters at harvest in tuberose cv. Prajwal

Treatment	Grasses	Sedges	Broad leaved	Weed control efficiency (%)	Weed index	Plant height (cm)	No. of leaves/ plant	Leaf area (cm^2)	Leaf area index
T_1 – Alachlor 50 EC @ 1.5 kg a.i /ha. (PE)	10.12(4.16)	4.67(3.16)	5.23(3.31)	78.83	39.21	55.30	30.46	1223.60	2.039
T_2 – Pendimethalin 30EC @ 1kg a.i/ ha (PE)	10.00(4.27)	3.33(2.83)	4.67(3.08)	84.30	37.72	54.35	31.13	1305.47	2.176
T_3 – Oxyfluorfen 23.5 EC @ 75 g a.i/ha (PE)	11.00(5.00)	4.67(3.16)	5.33(3.31)	72.49	40.71	53.78	28.00	1124.32	1.874
T_4 – Imazethapyr 10 SL @ 75g a.i/ ha (POE)	11.05(5.02)	4.90(2.91)	5.33(3.31)	76.04	42.20	52.18	28.16	1123.79	1.873
T_5 – Oxyfluorfen 23.5 EC @ 75 g a.i/ha (POE)	10.33(4.21)	5.67(3.63)	6.33 (3.52)	74.69	45.18	51.98	28.33	1105.33	1.842
T_6 – Pyrithiobac 10 EC @ 62.5 g a.i/ha (POE)	11.33(4.06)	5.33(3.31)	5.67(3.38)	70.90	47.68	51.29	27.53	1093.02	1.822
T_7 – weed free check	1.67(2.29)	1.33(2.15)	1.67(2.29)	97.23	0.00	57.71	34.33	1727.58	2.879
T_8 – Weedy check	36.00(7.00)	30.00(6.48)	33.67(6.80)	0.00	99.91	22.42	12.00	211.51	0.353
S.Em ±	2.07	1.13	2.48	2.30	0.57	0.86	0.55	19.74	0.03
C.D. at 5 %	6.28	3.43	7.52	7.00	1.73	2.63	1.69	59.87	0.09

PE – Pre emergence
POE – Post emergence Figures in paranthesis indicates square root ($\sqrt{X+1}$) transformed values

Table 2. Effect of weed control treatments on flowering and flower spike characters in tuberose cv. Prajwal

Treatment	Days taken for first flower initiation	Days taken for 50 % flowering	Days required for flower opening	Spike length (cm)	Rachis length (cm)	Number of florets per spike	Diameter of flower (cm)
T_1 – Alachlor 50 EC @ 1.5 kg a.i /ha.(PE)	101.33	113.33	21.66	80.85	17.56	32.86	4.26
T_2 – Pendimethalin 30EC @ 1kg a.i/ha (PE)	97.66	109.66	22.66	81.22	20.78	33.80	4.77
T_3 – Oxyfluorfen 23.5 EC @ 75 g a.i/ha (PE)	103.33	115.33	20.66	78.50	15.62	30.66	4.02
T_4 – Imazethapyr 10 SL @ 75g a.i/ha (POE)	105.33	117.33	20.33	80.26	13.83	29.26	3.84
T_5 – Oxyfluorfen 23.5 EC @ 75 g a.i/ha (POE)	115.00	128.66	19.33	79.32	13.92	28.26	3.67
T_6 – Pyrithiobac 10 EC @ 62.5 g a.i/ha (POE)	126.33	137.33	18.00	78.22	13.04	27.60	3.45
T_7 – weed free check	94.00	105.33	25.00	84.18	23.54	36.40	5.61
T_8 – Weedy check*	-	-	-	-	-	-	-
S.Em ±	0.89	1.37	0.37	0.18	0.47	0.31	0.09
C.D. at 5 %	2.70	4.17	1.12	0.56	1.43	0.94	0.28

PE – Preemergence POE – Post emergence

* - In weedy check (T_8), the plant could not initiate spikes and further flowering was absent due to total suppression of plants by weeds

Quality of spikes in terms of length of flower stalk was best in weed free check treatment (84.18cm) throughout the crop period. A marked difference in number of florets per spike was also recorded due to weed control treatments. Maximum flowers per spike was obtained in weed free check, pendimethalin 30EC @ 1 kg a.i/ha and alachlor 50EC @ 1.5 kg a.i/ha treatments (36.40, 33.80 and 32.86, respectively) (Table 2). This was due to better control of weeds during crop period in these treatments and also no phytotoxicity effects on the crop which resulted in better growth, early flowering and quality flowering. Shalini and Patil, 2006 while working on Gerbera reported 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 flowers per plant. Pendimethalin 30EC @ 1 kg a.i/ha, alachlor 50EC @ 1.5 kg a.i./ha and weed free check gave higher flower yield (3.67, 3.54 and 4.18 t/ha, respectively). (Table 3). The lowest flower yield (2.91 t/ha) was obtained in pyrithiobac 10 EC @62.5 g a.i/ha. This is due to severe wed competition which ultimately resulted in lower yield (Table 3). Rameshkumar *et al.* (2012) opined that integration of different weed management practices are better compared to chemical treatments. However, they found weed free treatment, pendimethalin were found effective in managing weeds and to produce higher yield per ha.

Economics

Among the weed control treatments, net returns were highest in weed free check throughout the crop period. Among the herbicides, pendimethalin 30EC @ 1 kg a.i/ha and alachlor 50EC @ 1.5 kg a.i/ha recorded the highest net returns (₹148722, ₹ 125492 and ₹ 120259, respectively). Highest profit (5.34) per rupee spent on weed control was obtained in pendimethalin 30 EC @ 1 kg a.i/ha followed by alachlor 50 EC @ 1.5 kg a.i/ha (2.66) because of lower cost of herbicide and more flower stalks per ha. In spite of higher marginal returns, the profit per rupee spent on weed control was low in weed free check because of higher cost of weed control by manual weeding.

Conclusion

Application of pendimethalin 30 EC @ 1 kg a.i/ha, alachlor 50 EC @ 1.5 kg a.i/ha and weed free check recorded the highest weed control efficiency. There was remarkable increase in yield of flower spike due to application of pendimethalin 30 EC @ 1 kg a.i/ha, alachlor 50 EC @ 1.5 kg a.i/ha and weed free check treatment. Highest profit per rupee spent on weed control was obtained in pendimethalin 30 EC @ 1 kg a.i/ha. Whereas, less profit per rupee invested was obtained in weed free check treatment as the cost of labour is more. Weed management in tuberose, hence, can be done by the combination of chemical and hand weeding.

Table 3. Effect of weed control treatments on flower yield and yield characters in tuberose cv. Prajwal

Treatment	Spike weight (g)	Weight of 100 florets (g)	Flower yield No. of spikes per hectare (in lakhs)	Flower yield (t/ha)
T_1 – Alachlor 50 EC @ 1.5 kg a.i /ha.(PE)	27.94	83.08	1.27	3.549
T_2 – Pendimethalin 30EC @ 1kg a.i/ha (PE)	28.46	85.21	1.29	3.673
T_3 – Oxyfluorfen 23.5 EC @ 75 g a.i/ha (PE)	27.45	81.45	1.25	3.431
T_4 – Imazethapyr 10 SL @ 75g a.i/ha (POE)	26.79	80.03	1.23	3.296
T_5 – Oxyfluorfen 23.5 EC @ 75 g a.i/ha (POE)	26.08	78.96	1.19	3.104
T_6 – Pyrithiobac 10 EC @ 62.5 g a.i/ha (POE)	25.16	78.23	1.15	2.910
T_7 – weed free check	31.19	88.21	1.34	4.180
T_8 – Weedy check	-	-	-	-
S. Em ±	0.65	0.28	0.66	0.04
C.D. at 5 %	1.97	0.86	2.02	0.13

PE – Preemergence POE – Post emergence

* - In weedy check (T_8), the plant could not initiate spikes and further flowering was absent due to total suppression of plants by weeds

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