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Influence of pre and post emergence herbicides on economics of tomato cv. Arka Vikas

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Abstract
Weed interference in tomato (*Solanum lycopersicum* L.) reduces fruit yield and economic return in tomato growers who pay for labour. A field experiment was conducted at Horticultural college and Research Institute, Dr. Y.S.R Horticultural University, Venkataramannagudem, Tadepalligudem, West Godavari District, A.P during Rabi season of 2011-12 and 2012-13 to study the influence of pre and post emergence herbicides on economics of tomato cv. Arka Vikas. The experiment consisted of 10 treatments of Pre and post emergence herbicides (Pendimethalin, Oxyflourfen, Imazethapyr and Quizalofop ethyle) and their combinations which were replicated in Randomized block design. Significantly higher gross returns and net returns were realized in the T_9 (weed free- hand weeding at 30, 60, 90 DAT) over rest of the treatments, followed by application of T_8 (Oxyfluorfen 0.125 kg a.i ha^{-1} as PE + Quizalofopethyl @ 75 g a.i ha^{-1} (POE) and T_6 (Pendimethalin @ 0.75 kg a.i/ha + Quizalofop ethyl @ 75 a.i/ha). While, the B:C ratio was significantly higher in T_8 (Oxyfluorfen @ 0.125 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE) followed by T_6 (Pendimethalin @ 0.75 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE). Hand weeding increased the cost of cultivation. This implied that chemical weed control was found superior to get maximum profit per hectare.

Keywords: Pendimethalin, oxyflourfen, imazethapyr, quizalofopethyle tomato

Introduction
Tomato (*Solanum lycopersicon*, L.) is one of the most popular and widely grown vegetables in the world, ranking second in importance to potato in many countries. The fruits are eaten raw or cooked. Tomato supplies vitamin C and adds variety of colours and flavours to the foods. Tomato is also rich in medicinal value. The pulp and juice are digestible, promoter of gastric secretion and blood purifier. It is also considered to be intestinal antiseptic. It is one of the richest vegetables which keeps our stomach and intestine in good condition.

The major tomato producing states in the country are Madhya Pradesh, Andhra Pradesh, Karnataka, Gujarat, Odisha, Chhattisgarh, West Bengal, Tamil Nadu, Bihar, Maharashtra, Uttar Pradesh, Haryana and Telangana. These states account for about 90% of the total production in the country. At present, the production share of tomato is 11.2 per cent of the total vegetable production with 9.6 percent of the total vegetable area in the country. In India it is being grown in an area of 0.87 million hectares with a production of 18.22 million tonnes and the productivity is 20.7 tonnes per hectare. Andhra Pradesh is leading state in tomato production, it accounts 28.63 percent of total tomato production in India. In Andhra Pradesh it is cultivated in an area of 2.60 lakh hectares with a production of 52.18 lakh tonnes and the average productivity is 20tonnes per hectare. (Indian Horticultural Database, 2013)

Tomato being a cash vegetable crop brings good income to farmers and particularly around big cities. Weeds in tomato pose a serious problem and as such weed competition is severe during early stages of the crop. Wider spacing, frequent irrigations and liberal use of manures and fertilizers in the cultivation of tomato provide favourable conditions for the luxuriant weed growth particularly during early stages of the crop (Govindra Singh *et al.*, 1984) [3].

The potential of a high yielding variety of a crop cannot be realized if nutrition, light or water supplies become limiting factors due to heavy competition from weeds that emerge and grow along with the crop plants. A yield loss of 57.5 percent was reported by Singh and Singh (1992) [9] and 42.71 percent (Singh and Tripathi, 1988) [8] due to weed competition in tomato.

The common practice of weed control in tomato is manual weeding. Frequent weedings and timely weed control are required to avoid severe damage to the crop. The realization of crop yield potential depends on degree of weed control.

The mechanical or manual method of weed control often does not meet the requirements. Herbicides are required for weed control not only in situations where labour is scarce and expensive but also in situations where mechanical and manual control measures are interrupted by unfavourable conditions of soil due to excess or failure of rains. Under such conditions, use of herbicides may be an appropriate step to prevent early damage to the crop. Increased use of herbicides for weed control is due to the easy application and effectiveness in early control of weeds (Virender Sardana, 1997) [13]. In recent decades the predominant weed control method in many parts of the developed world is the use of effective and reliable herbicides (Powles *et al*., 1997) [6].

Economic considerations, particularly profit, are important in driving adoption of agricultural innovation (Pannell *et al*., 2006) [5]. It is possible that practices producing the best yield may not necessarily translate to the best economic return. There is inadequate information for smallholder farmers about weed control methods that would contribute to improved yield and provide trade-off in economic implications in tomato production. The experiment was undertaken to determine the performance of Pre and Post Emergence Herbicides and its economic benefit in tomato production.

Material and Method

Economics (Rs): Cost of cultivation for each treatment was worked out separately gross returns (Rs ha^{-1}) was obtained by converting the harvest in to monetary terms at the prevailing market rate during the course of investigation. Net return was obtained by deducting cost of cultivation from gross return. The benefit: cost ratio was calculated with the help of following formula (Reddy *et al.*, 2004) [14]

$$\text{Benefit cost ratio} = \frac{\text{Gross returns (Rs)}}{\text{Total Cost of Cultivation}}$$

Results and Discussion

Fruit yield (t ha^{-1})

All the weed control treatments significantly influenced the fruit yield of tomato and the data are presented in the table 2. All the weed management practices except T3 (Imazethapyr @ 60 g a.i / ha as POE), T5 (Pendimethalin @ 0.75 kg a.i / ha as PE + Imazethapyr @ 60 g a.i / ha as POE) and T7 (Oxyfluorfen @ 0.125 kg a.i / ha as PE Imazethapyr @ 60 g a.i / ha as POE) produced significantly higher yield of tomato per ha over T10 (weedy check).

Among the treatments, maximum fruit yield of tomato per ha was recorded in T9 (Weed free -Hand weeding at 20, 40 and 60 DAT) treatment which was statistically on par with T8 (Oxyfluorfen @ 0.125 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE).

Treatments T6 (Pendimethalin @ 0.75 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE), T1 (Pendimethalin @ 0.75 kg a.i / ha as PE), T2 (Oxyfluorfen @ 0.125 kg a.i / ha as PE) and T4 (Quizalofop ethyl @ 75 g a.i / ha as POE) produced significantly higher yield over weedy check (T10) during both the years of study. Significantly lower yield in weedy check may be due to severe competition for plant nutrients, water and light between crop and weeds. Similar results were also reported by Balraj Singh (1994) [2], Ram *et al.* (1994) [7], Muniyappa *et al.* (1995) [4], Tumbare and Ilhe (2004) [10] and Warade *et al.* (2008) [12].

T3 (Imazethapyr @ 60 g a.i / ha as POE), T5 (Pendimethalin @ 0.75 kg a.i / ha as PE+Imazethapyr @ 60 g a.i / ha as POE) and T7 (Oxyfluorfen @ 0.125 kg a.i / ha as PE Imazethapyr @ 60 g a.i / ha as POE) produced lower fruit yield than weedy control during both the years of study. Among the three treatments, lowest fruit yield was recorded in T3, however it remained on par with T5 (Pendimethalin @ 0.75 kg a.i / ha as PE+ Imazethapyr @ 60 g a.i / ha as POE) and T7 (Oxyfluorfen @ 0.125 kg a.i / ha as PE Imazethapyr @ 60 g a.i / ha as POE).

Influence of Pre and Post Emergence Herbicides on economics of Tomato cv. Arka Vikas and data were presented in Table-2. Significantly higher gross returns and net returns were realized in the T9 (weed free- hand weeding at 30, 60, 90 DAT) over rest of the treatments, followed by application of T8 (Oxyfluorfen 0.125 kg a.i ha^{-1} as PE + Quizalofopethyl @ 75g a.i ha^{-1} (POE) and T6 (Pendimethalin @ 0.75kg a.i/ha + Quizalofop ethyl @ 75 a.i/ha). This can be attributed to better control of weeds in these treatments resulting in increased fruit yield and thereby increasing the gross returns. However gross returns were significantly lowest in Imazethapyr @ 60g ai ha^{-1} (T3) POE compared to rest of the treatments. This can be attributed to lower fruit yield due to phytotoxicity.

The B:C ratio was significantly higher in T8 (Oxyfluorfen @ 0.125 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE) followed by T6 (Pendimethalin @ 0.75 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE). This was attributed to lower cost of cultivation in these treatments compared to T9 (weed free- Hand weeding at 20, 40 & 60 DAT). This implied that chemical weed control was found superior than old age practice of hand weeding in controlling the weeds in tomato crop to get maximum profit per hectare.

Similar findings were also reported by Balraj Singh (1994) [2], Muniyappa *et al.* (1995) [4], Ved Prakash *et al.* (2000) [11] and Ankur vermani *et al.* (2001) [1].

Table 1: Influence of Pre and Post Emergence Herbicides on Fruit yield of Tomato cv. Arka Vikas

	Treatment	Yield (t/ha)	
		I year	II year
T_1	Pendimethalin @ 0.75 kg a.i / ha as PE	18.52	20.24
T_2	Oxyfluorfen @ 0.125 kg a.i / ha as PE	18.87	20.86
T_3	Imazethapyr @ 60 g a.i / ha as POE (20 DAT)	3.88	3.78
T_4	Quizalofop ethyl @ 75 g a.i / ha as POE (20 DAT)	16.92	17.84
T_5	Pendimethalin @ 0.75 kg a.i / ha as PE + Imazethapyr @ 60 g a.i / ha as POE (20 DAT)	4.25	4.13
T_6	Pendimethalin @ 0.75 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE (20 DAT)	21.59	23.42
T_7	Oxyfluorfen @ 0.125 kg a.i / ha as PEImazethapyr @ 60 g a.i / ha as POE (20 DAT)	4.66	4.59
T_8	Oxyfluorfen @ 0.125 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE (20 DAT)	21.98	23.91
T_9	Weed free (Hand weeeding at 20, 40 and 60 DAT)	26.50	29.20
T_{10}	Weedy Check	12.85	13.24
	S.Em+	1.38	1.16
	CD (P=0.05)	4.12	3.46

Table 2: Influence of Pre and Post Emergence Herbicides on economics of Tomato cv. Arka Vikas

	Treatment	Cost of cultivation (Rs. ha^{-1})	Gross returns (Rs. ha^{-1})		Net Returns (Rs. ha^{-1})		B:C ratio	
			I year	II year	I year	II year	I year	II year
T_1	Pendimethalin @ 0.75 kg a.i / ha as PE	49910	129647	141694	79737	91784	2.60	2.84
T_2	Oxyfluorfen @ 0.125 kg a.i / ha as PE	49210	132083	146048	82873	96838	2.68	2.97
T_3	Imazethapyr @ 60 g a.i / ha as POE (20 DAT)	49310	27153	26460	-22157	-22850	0.55	0.54
T_4	Quizalofop ethyl @ 75 g a.i / ha as POE (20 DAT)	50710	118447	124866	67737	74156	2.34	2.46
T_5	Pendimethalin @ 0.75 kg a.i / ha as PE + Imazethapyr @ 60 g a.i / ha as POE (20 DAT)	50810	29750	28910	-21060	-21900	0.59	0.57
T_6	Pendimethalin @ 0.75 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE (20 DAT)	52210	151144	163954	98934	111744	2.89	3.14
T_7	Oxyfluorfen @ 0.125 kg a.i / ha as PE Imazethapyr @ 60 g a.i / ha as POE (20 DAT)	50110	32620	32130	-17490	-17980	0.65	0.64
T_8	Oxyfluorfen @ 0.125 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE (20 DAT)	51510	153825	167391	102315	115881	2.99	3.25
T_9	Weed free (Hand weeding)	66410	185500	204372	119090	137962	2.79	3.08
T_{10}	Weedy Check	48410	89922	92694	41512	44284	1.86	1.91

PE- Pre emergence
POE- Post emergence
DAT- Days after transplanting
B: C ratio – Benefit: Cost ratio
Price of tomato – Rs. 7 kg^{-1}

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