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RESEARCH ARTICLE :

Performance of pre and post emergence herbicides on weed dynamics in tomato cv. ARKA VIKAS

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SUMMARY : A fieid experiment was conducted to study the performance of pre and post emergence herbicides on weed dynamics in Tomato cv. ARKA VIKAS during *Rabi* 2011-12 and 2012-13. The experiment consisted of 10 treatments of Pre and post emergenceherbicides (Pendimethalin, Oxyflourfen, Imazethapyr and Quizalofop ethyle) and their combinations which were replicated in Randomized Block Design. All the weed control treatments significantly reduced the density of weeds and weed dry matter effectively. Pre emergence herbicides coupled with Quizalofop ethyle found to be onpar with Hand weeding. Though imazethapyr apllied as post emergence, effectively controls the weeds but found to be extremely toxic to the crop. The maximum yield of tomato was recorded with Hand weeding, which is similar to the application of pre emergence herbicides combined with Quizalofop ethyle @ 75g a.i per ha.

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KEY WORDS :
Pendimethalin, Oxyflourfen, Imazethapyr, Quizalofopethyle tomato

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BACKGROUND AND OBJECTIVES

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 add 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.At present, the production share of tomato is 11.2 per cent of the total vegetable production with 9.6 per cent of the total vegetable area in the country. In India it is being grown in an area of 8.7 lakh hectares with a production of 182.2 lakh tonnes and the productivity is 20.7tonnes per hectare. Andhra Pradesh is leading state in tomato production, it accounts 28.63per cent of total tomato production in India. In Andhra Pradesh it is cultivated in an area of 2.60lakh hectares with a production of 52.18 lakh tonnes and the average productivity is 20tonnes per hectare. (Indian Horticultural Database, 2015)

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). So to raise the health crop, weed management is essential. Chemical weed control is becoming popular due to its cost effectiveness over cultural control. Hence an experiment was conducted to examine the performance of pre and post emergence herbicides and their combination to find out the best weed management practices in tomato.

RESOURCES AND METHODS

An 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. The experimental farm is situated at 16.83^0N latitude and 81.5^0E longitude. The soil was acidic in reaction and medium in NPK availability. The texture of the soil was sandy loam. The experiment was laid out in Randomized block design with three replications in a plot size of 4X3 m^2.

The seeds of Tomato cultivar "Arka vikas" was sown for nursery raising and transplanting was done on ridge and furrow system by adopting spacing of 60X45cm. The ten treatments consists of T_1- Pendimethalin @ 0.75 Kg a.i / ha as pre emergence application, T_2- Oxyfluorfen @ 0.125 Kg a.i / ha as pre emergence application, T_3- Imazethapyr @ 100 g a.i / ha as post emergence application (20 DAT), T_4- Quizalofop ethyl @ 75 g a.i / ha as post emergence application (20 DAT), T_5- Pendimethalin @ 0.75 Kg a.i / ha as pre emergence application + Imazethapyr @ 100 g a.i / ha as post emergence application (20 DAT), T_6- Pendimethalin @ 0.75 Kg a.i / ha as pre emergence application+ Imazethapyr @ 100 g a.i / ha as post emergence application (20 DAT), T_7- Oxyfluorfen @ 0.125 Kg a.i / ha as pre emergence application + Quizalofop ethyl @ 75 g a.i / ha as post emergence application (20 DAT), T_8- Oxyfluorfen @ 0.125 Kg a.i / ha as pre emergence application + Quizalofop ethyl @ 75 g a.i / ha as post emergence application (20 DAT), T_9- Weed free (Hand weeding) and T_{10}- Weedy check.

Twenty five days old seedlings were used for transplanting. All the package of practices to raise the good crop was done in the experimental field and weed control treatments applied as per the treatments. Weed population counts were taken from an area of one sq.m. from the net plot of each treatment and in each replication at 19 DAT, 30DAT, 60 DAT and 90 DAT. Species wise weed count was recorded and weed dynamics were calculated. The data on weed density and weed dry matter showed considerable variation and hence were subjected to square root transformation ($\sqrt{X+0.5}$) before analyzing statistically where, X is original value.

The weed control efficiency (WCE) and weed index (WI)were calculated by using the following formulae:

$$\%\ WCE = \frac{\text{Weed dry matter in untreated plot} - \text{weed dry matter in treat}}{\text{Weed dry matter in untreated plot}}$$

$$WI = \frac{\text{Yield from weed free plot} - \text{Yield from treatment plot matter in treat}}{\text{Yield from weed free plot}}$$

The data recorded on weed population, weed dry matter production (WDMP), weed control efficiency (WCE), Weed Index (WI) and fruit yield was depicted in Table 1 and 2, respectively.

OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well as discussions have been summarized under following heads:

Weed density (No.m^{-2}) and Weed dry matter (g $plant^{-1}$):

Densityof total weeds and weed dry matter were significantly influenced by weed management practices. Minimum density of total weeds and weed dry matter were recorded with T_9(Weed free -Hand weeding at 20, 40 and 60 DAT) treatment, which was statistically on par with T_8(Oxyfluorfen @ 0.125kg a.i/ha + Quizalofop ethyl @ 75g a.i/ha), during all stages of crop growth and comparable with T_6(Pendimethalin @ 0.75kg a.i/ha + Quizalofop ethyl @ 75 a.i/ha). Highest density of total weeds and weed dry matter were noticed with T_{10} (weedy check) which was significantly differed with all other treatments during different stages of crop growth.

The results revealed that, the density of weeds at all stages of crop growth was registered maximum with T10 (weedy check) treatment. Lowest density of weeds was recorded with T_9 (hand weeding at 20, 40 and 60

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Table 1 : Total weed density and total dry matter of weeds (g plant^{-1}) at various growth stages of tomato crop as influenced by weed management practices

	Treatments	Total weed density (No.m^{-2})								Total dry matter of weeds (g plant^{-1})							
		19 DAT		30 DAT		60 DAT		90 DAT		19 DAT		30 DAT		60 DAT		90 DAT	
		2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
T_1	Pendimethalin @ 0.75 kg a.i / ha as PE	14.34 (3.84)	15.33 (3.98)	36.54 (6.06)	44.50 (6.68)	97.90 (9.85)	103.78 (10.19)	181.54 (13.47)	196.10 (13.99)	1.22 (1.31)	1.35 (1.36)	4.18 (2.16)	4.30 (2.19)	34.44 (5.89)	34.04 (5.82)	139.18 (11.79)	162.98 (12.76)
T_2	Oxyfluorfen @ 0.125 kg a.i / ha as PE	012.7 (3.63)	13.28 (3.71)	34.56 (5.88)	38.80 (6.25)	90.66 (9.54)	97.72 (9.84)	155.71 (12.49)	185.80 (13.58)	1.05 (1.24)	1.29 (1.34)	3.85 (2.08)	4.05 (2.13)	30.54 (5.54)	31.89 (5.68)	129.67 (11.39)	157.17 (12.52)
T_3	Imazethapyr @ 60 g a.i / ha as POE (20 DAT)	25.61 (5.11)	26.45 (5.19)	50.67 (7.11)	58.84 (7.70)	179.35 (13.39)	171.70 (13.07)	254.22 (15.93)	301.32 (17.33)	17.94 (4.29)	18.82 (4.39)	7.75 (2.87)	7.11 (2.75)	54.53 (7.40)	42.40 (6.53)	194.53 (13.93)	195.34 (13.96)
T_4	Quizalofop ethyl @ 75 g a.i / ha as POE(20 DAT)	29.31 (5.44)	27.78 (5.31)	37.38 (6.15)	50.85 (7.14)	101.25 (10.07)	114.99 (10.72)	200.05 (14.10)	206.52 (14.34)	18.58 (4.37)	20.32 (4.56)	4.62 (2.26)	4.44 (2.22)	38.22 (6.17)	34.94 (5.94)	145.16 (12.02)	170.70 (13.06)
T_5	Pendimethalin @ 0.75 kg a.i / ha as PE +Imazethapyr @ 60 g a.i / ha as POE(20 DAT)	17.16 (4.20)	15.85 (4.02)	45.83 (6.77)	51.15 (7.17)	176.35 (13.29)	160.15 (12.64)	241.22 (15.53)	276.45 (16.58)	1.15 (1.28)	1.32 (1.35)	6.53 (2.64)	5.93 (2.53)	50.22 (7.11)	40.01 (6.35)	176.34 (13.21)	190.78 (13.78)
T_6	Pendimethalin @ 0.75 kg a.i / ha as PE + Quizalcfop ethyl @ 75 g a.i / ha as POE (20 DAT)	14.92 (3.92)	14.70 (3.89)	30.15 (5.49)	32.38 (5.72)	68.33 (8.27)	74.46 (8.63)	150.97 (12.22)	162.91 (12.71)	1.07 (1.25)	1.30 (1.34)	3.29 (1.94)	3.02 (1.87)	26.53 (5.16)	26.24 (5.15)	124.95 (11.17)	131.19 (11.45)
T_7	Oxyfluorfen @ 0.125 kg a.i / ha as PEImazethapyr @ 60 g a.i / ha as POE(20 DAT)	14.08 (3.81)	13.41 (3.70)	41.66 (6.48)	50.92 (7.15)	157.82 (12.55)	154.91 (12.43)	235.63 (15.31)	266.42 (16.26)	0.97 (1.21)	1.16 (1.29)	5.10 (2.36)	5.35 (2.41)	43.48 (6.60)	37.37 (6.13)	173.90 (13.15)	183.23 (13.54)
T_8	Oxyfluorfen @ 0.125 kg a.i / ha as PE + Quizalcfop ethyl @ 75 g a.i / ha as POE (20 DAT)	12.49 (3.60)	12.06 (3.54)	23.92 (4.93)	27.03 (5.22)	56.47 (7.53)	68.31 (8.34)	142.18 (11.56)	143.36 (11.72)	0.92 (1.19)	1.08 (1.26)	2.86 (1.83)	2.72 (1.79)	23.96 (4.91)	24.62 (4.98)	120.96 (10.96)	122.07 (11.03)
T_9	Weed free (Hand weeding at 20, 40 and 60 DAT)	30.57 (5.56)	35.32 (5.53)	16.95 (4.16)	18.02 (4.29)	49.54 (6.99)	44.03 (7.05)	90.64 (9.49)	103.77 (10.04)	19.32 (4.45)	20.96 (4.63)	2.26 (1.65)	1.86 (1.52)	17.57 (4.23)	18.96 (4.35)	85.80 (9.26)	90.00 (9.38)
T_{10}	Weedy Check	34.33 (5.82)	35.42 (5.78)	96.20 (9.82)	113.8 (10.66)	212.14 (14.55)	240.78 (15.51)	402.22 (20.03)	424.38 (20.58)	20.67 (4.60)	22.07 (4.75)	33.00 (5.78)	30.78 (5.59)	133.01 (11.54)	138.07 (11.75)	302.28 (17.38)	325.26 (18.02)
	S.E.±	0.29	0.20	0.37	0.36	0.57	0.67	0.80	0.58	0.12	0.15	0.13	0.12	0.39	0.42	0.69	0.69
	C.D. (P=0.05)	0.86	0.61	1.09	1.06	1.72	2.01	2.41	1.73	0.36	0.45	0.38	0.36	1.17	1.25	2.09	2.08

PE- Pre emergence
POE- Post emergence
DAT- Days after transplanting
*Figures in parenthesis are indicating transformed values

DAT) at all stages of crop growth. This might be due to complete removal of all types of weeds by hand weeding. These results are in confirmity with the finding of Gurcharan *et al.* (1994), who stated that all the weed control treatments including hand weeding resulted in 79.6-85.1% control of weeds compared to weedy check in their studies. Similar results were obtained by Ram *et al.* (1994); Ushakumari *et al.* (2001); Tumbare and Ilhe (2004); Manjunatha (2005) and Nandal and Sharma (2005). The lower dry weight of weeds was due to decreased weed population due to effective control of weeds and prolonged effectiveness of pre emergence herbicides in combination with Quizalofop ethyl @ 75g a.i/ha as POE. These results are in confirmity with those reported by Ram *et al.*(1994) and Nandal and Sharma (2005).

Treatments having a combination of pre emergence herbicides + Quizalofop ethyl @ 75g a.i ha (POE) effectively controlled the weeds at all stages of crop growth. This might be due to high efficacy of Quizalofop ethyl in destroying the weeds in addition to action of pre emergence herbicides.

Weed control efficiency (WCE) :

Weed control efficiency is per cent reduction in dry matter of weeds in comparison to weedy check. The efficacy of herbicide can be measured by values of WCE. The greater the values, the higher the efficacy of herbicides to the weeds. At 30, 60 and 90 DAT, the treatment T_9 (weed free-hand weeding at 20, 40 and 60 DAT) recorded greatest weed control efficiency followed by T_8 (oxyflourfen @ 0.125kg a.i/ha + Quizalofop ethyl @ 75g a.i/ha) and T6 (Pendimethalin @ 0.75kg a.i/ha + Quizalofop ethyl @ 75 a.i/ha).This might be due to lowest weed density and weed dry weight recorded in these plots. This implies that better efficacy and longer persistence for controlling the weeds with application of pre emergence herbicides coupled with Quizalofop ethyl as POE. Similar results were reported by Ram *et al.* (1994); Nandal and Sharma (2005); Manjunatha (2005); Kathiresan *et al.* (2004) and Meena and Mehta (2009).

The lowest weed control efficiency at 60 and 90

Table 2 : Weed control efficiency (%), weed index (%) and fruit yield (t ha^{-1}) at various growth stages of tomato crop as influenced by weed management practices

	Treatments	Weed control efficiency (%)								Weed index (%)		Fruit yield (t ha^{-1})	
		19 DAT		30 DAT		60 DAT		90 DAT					
		2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
T_1	Pendimethalin @ 0.75 kg a.i / ha as PE	94.10	93.88	87.35	86.03	73.81	75.35	57.10	51.68	30.11	30.67	18.52	20.24
T_2	Oxyfluorfen @ 0.125 kg a.i / ha as PE	94.92	94.15	88.32	86.83	77.04	76.90	53.96	49.89	28.80	28.54	18.87	20.86
T_3	Imazethapyr @ 60 g a.i / ha as POE (20 DAT)	13.21	14.73	76.50	76.89	59.00	69.29	35.65	39.94	85.36	87.05	3.88	3.78
T_4	Quizalofop ethyl @ 75 g a.i / ha as POE (20 DAT)	10.11	7.93	86.02	85.59	71.27	74.69	51.98	47.52	36.15	38.90	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)	94.44	94.02	80.21	80.73	62.25	71.02	41.66	41.35	83.96	85.85	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)	94.82	94.11	90.03	90.19	80.05	81.00	58.66	59.67	18.52	19.78	21.59	23.42
T_7	Oxyfluorfen @ 0.125 kg a.i / ha as PEImazethapyr @ 60 g a.i / ha as POE (20 DAT)	95.31	94.74	84.56	82.62	67.31	72.93	42.47	43.67	82.42	84.28	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)	95.55	95.11	91.34	91.15	81.99	82.17	59.99	62.47	17.08	18.09	21.98	23.91
T_9	Weed free (Hand weeding at 20, 40 and 60 DAT)	6.53	5.03	93.16	93.97	86.79	86.26	71.61	72.33	--	--	26.50	29.20
T_{10}	Weedy check	--	--	--	--	--	--	--	--	51.52	54.64	12.85	13.24
S.E.±												1.38	1.16
C.D. (P=0.05)												4.12	3.46

PE- Pre emergence POE- Post emergence DAT- Days after transplanting

DAT was recorded with T_3 (Imazethapyr @ 60g a.i/ha as POE) followed by T_5 (Pendimethalin @ 0.75 kg a.i / ha as PE +Imazethapyr @ 60 g a.i / ha as POE) and T_7 (Oxyfluorfen @ 0.125 kg a.i / ha as PE + Imazethapyr @ 60 g a.i / ha as POE) as these plots recorded more dry weight of weeds and found extremely toxic to tomato crop.

Weed index (%) :

The effectiveness of herbicides can be judged based on weed index values. During both the years of study, minimum values were recorded in the T_8 (Oxyfluorfen @ 0.125 kg a.i/ha (PE) +Quizalofop ethyl @ 75g a.i/ha POE), followed by T_6 (Pendimethalin @ 0.75 kg a.i /ha (PE) + Quizalofop ethyl @ 75 g a.i/ha as POE).This could be due to maximum yield recorded in T_8 (Oxyfluorfen @ 0.125 kg a.i/ha (PE) + Quizalofop ethyl @ 75g a.i/ha POE), while Imazethapyr @ 60 g a.i/ha (POE) applied alone and in combination with Pendimethalin and Oxyfluorfen recorded maximum values over the weedy check (T_{10}), it might be due to poor yield recorded in these plots because of extreme phytotoxicity of Imazethapyr to the tomato crop.

Pre emergence application of both Pendimethalin @ 0.75kg a.i/ha and Oxyfluorfen @ 0.125 Kg ai/ha applied alone produced the intermediate values for weed index. These results were in confirmity with those reported by Ram *et al.* (1994); Manjunatha (2005); Kathiresan *et al.* (2004); Channappagoudar *et al.* (2007) and Meena and Mehta (2009).

Fruit yield (t ha $^{-1}$) :

All the weed management practices except T3 (Imazethapyr @ 60 g a.i / ha as POE), T_5 (Pendimethalin @ 0.75 kg a.i / ha as PE + Imazethapyr @ 60 g a.i / ha as POE) and T_7 (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 T_{10} (weedy check).

Among the treatments, maximum fruit yield of tomato per ha was recorded in T_9 (Weed free -Hand weeding at 20, 40 and 60 DAT) treatment which was statistically on par with T_8 (Oxyfluorfen @ 0.125 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE).

Treatments T_6 (Pendimethalin @ 0.75 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE), T_1 (Pendimethalin @ 0.75 kg a.i / ha as PE), T_2 (Oxyfluorfen @ 0.125 kg a.i / ha as PE) and T_4 (Quizalofop ethyl @ 75 g a.i / ha as POE) produced significantly higher yield over weedy check (T_{10}) 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 Singh (1994); Ram *et al.* (1994); Muniyappa *et al.* (1995); Tumbare and Ilhe (2004) and Warade *et al.* (2008). T_3 (Imazethapyr @ 60 g a.i / ha as POE), T_5 (Pendimethalin @ 0.75 kg a.i / ha as PE+Imazethapyr @ 60 g a.i / ha as POE) and T_7 (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 as Imazethapyr found to be phytotoxic to the tomato crop.

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