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Integrated weed management in tomato (*Lycopersicon esculentum* Mill) under dry temperate climate of western Himalayas

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ABSTRACT

A field experiment was conducted at Highland Agricultural Research and Extension Centre, Kukumseri (Himachal Pradesh) during 2010 and 2011 to develop weed management practice for tomato (Lycopersicon esculentum Mill) under dry temperate conditions of western Himalayas. Application of pendimethalin @1.5 kg ai ha^{-1} and fluchloralin @ 1.0 kg ai ha^{-1} being equally effective gave maximum control of weed by lowering the weed density, weed dry matter accumulation and thereby recording higher weed control efficiency of 97.5 and 98.5%, respectively. However treatment two hand weedings at 30 and 60 DAT was also statistically at par with these above treatments giving weed control efficiency of 97.8%.These three treatments were also statistically at par with each other for average fruit weight, number of fruits per plant with corresponding fruit yield of 21.80, 21.08 and 23.23 t ha^{-1}, respectively .The highest net return of INR 3, 82,196 ha^{-1} and B: C ratio of 4.63 was obtained with treatment two hand weeding(30 and 60 DAT) which was followed by application of pendimethalin @1.5 kg ai ha^{-1} (net return INR 3, 75,153 and B:C ratio 5.01).

Keywords : Fruit yield and economics, herbicides, tomato, weeds

North Western Himalayas has a climate from dry to wet temperate to subtropical suitable for cultivation of vegetables. The Lahaul and Spiti valley in western Himalayas has dry temperate climate for six months of year with rainfall below 150 mm in season(Anon., 2011). As compared to earlier times with promotion of tourism and outreach of people the demand for tomato in this tribal belt has increased and so as the practice of cultivation. Being a dry temperate region with low humidity and light texture soils the demand for irrigation is 2-3 in a week which aggravates the weeds problem. The magnitude of loss due to weeds depends upon the weeds flora, period of crop-weed competition and intensity. Being a transplanted crop establishment takes time hence may suffer early weed competition (Zimdahl, 1980) and removing this early weed competition to avoid yield losses. Infestation of transplanted tomato with barnyard grass and blacknight shade can cause loss up to 49 to 64 % (Weaver and Tan, 1983). The region has sparse population and availability of labour is very low so taking up transplanted vegetable cultivation will require that as far as possible the weeds should be controlled through use of herbicide. The literature on the weed control in tomato under dry temperate region of western Himalayas is scarce .The objective of this research was to develop a cost effective weed management strategy using the herbicides for control of weeds in tomato.

MATERIALS AND METHODS

Field experiment was conducted at research farm of Highland Agricultural Research and Extension Centre, Kukumseri (32º 44' 55''N latitude and 76 º 41'23'' E longitudes), CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, India during 2009-10 and 2010-11 growing season. The soil of experimental site was sandy loam, having pH 6.8, organic carbon 6.82 g kg^{-1}soil, available nitrogen 305.4 kg ha^{-1}, phosphorus 19.3 kg ha^{-1} and potassium 149.1 kg ha^{-1}.The experiment was laid out in randomised block design with three replications, consisting of 10 treatments *viz*.

T_1- Metribuzin @ 0.25kg ai ha^{-1}(PPI)
T_2- Pendimethalin @1.5 kg ai ha^{-1}(PE)
T_3- Fluchloralin@ 1.0 kg ai ha^{-1} (PPI)
T_4- Metribuzin @0.25 kg ai ha^{-1} at 21DAT (days after transplanting)
T_5- Pendimethalin @ 0.75 kg ai ha^{-1}(PE) + Metribuzin @ 0.15 kg ai ha^{-1} at 30 DAT
T_6- Fluchloralin @0.75 kg ai ha^{-1}(PPI) + Metribuzin @0.15kg ai ha^{-1} at 30 DAT
T_7- Metribuzin @0.25 kg ai ha^{-1} (PPI)+ hand weeding at 30DAT
T_8- Pendimethalin @0.75 kg ai ha^{-1} (PE) + hand weeding at 30 DAT
T_9- Two hand weedings at 30 and 60 DAT
T_{10}- Weedy check

The plot size was 3.60 × 3.15 m. The 3-4 leaf healthy seedling of variety 'Avtar' raised in poly house were transplanted in field after hardening period outside polyhouse of 2 days. The transplanting was done on 30 May, 2010 and 25 May, 2011.The crop was fertilized with N, P_2O_5 and K_2O @150, 120 and 55 kg ha^{-1}, respectively. The nitrogen was applied in form of urea , P_2O_5 in form of single super phosphate and K_2O in form

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of muriate of potash .The half of nitrogen, full P_2O_5 and K_2O were applied at the time of transplanting .The remaining nitrogen was applied in two split of 1/4 at 30 DAT and 1/4 nitrogen at time of flowering. The number of irrigations was 2-3 per week depending upon the demand. The herbicides were applied with manually operated knapsack sprayer delivering a spray volume of 500 litres of water per hectare. The observation on weed density separated into narrow and broadleaf weeds, weed dry matter accumulation at 30 DAT and at harvest and weed control efficiency was calculated as per standard procedure. The crop was harvested in three lots and summed up for total yield. The economics based on the prevailing market prices was calculated. The data recorded was statistically analysed for interpretation (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Weed flora

The dominant broadleaf weeds were: *Amaranthus spinosus* L., *Gallinsoga parviflora* Cav., *Coronopus didymus* L. and monocots weeds were: *Digitaria sangunalis* L., *Poa annua* L., *Avena fatua* L. Other weeds were *Polygonum alatum* L., *Malva parviflora* L., *Chenopodium botrys* L., *Setaria galuca* L., *Panicum dicotomiflorum* L. and *Medicago denticulate* Willd.

Table 1: Effect of weed control treatments on the weed density, biomass and weed control efficiency

Treatments	Weed dry matter (g sqm^{-1})				Weed control efficiency (%)		Weed count
	30 DAT		At harvest		30 DAT	At harvest	(sq m^{-1})
	Narrow	Broad	Narrow	Broad	(sq m^{-1})		
T_1	6.00(2.47)	0.00(1.00)	11.16(3.33)	0.00(1.00)	5.27(2.40)	15.72(4.04)	91.7
T_2	0.00 (1.00)	4.77(2.17)	0.33(1.12)	3.66(1.98)	3.22(1.94)	5.08(2.45)	97.5
T_3	0.33(1.12)	6.00(2.59)	0.33(1.12)	1.16(1.41)	9.55(3.12)	2.32(1.81)	98.5
T_4	6.50 (2.65)	94.66(8.40)	13.16 (3.60)	205.83(14.15)	59.93 (7.79)	163.05(12.78)	12.7
T_5	3.66 (1.78)	13.24 (3.80)	14.16 (3.39)	125.00(11.02)	11.13 (3.44)	127.25(11.30)	31.8
T_6	0.33(1.12)	4.66(2.28)	20.00 (4.58)	55.83(7.54)	8.59(3.36)	88.92(9.56)	52.3
T_7	8.02(3.00)	1.00(1.41)	20.77 (1.24)	0.33(1.12)	13.33 (3.36)	18.14(4. 46)	90.3
T_8	0.16(1.06)	2.66(1.74)	0.00(1.00)	6.16(2.61)	2.5 0(1.77)	8.43(3.04)	95.5
T_9	1.33 (1.41)	46.00 (5.28)	4.16(2.18)	7.82 (3.02)	10.30 (3.20)	4.22 (2.36)	97.8
T_{10}	9.83 (3.24)	124.66(10.17)	18.33 (4.12)	242.33(15.29)	93.13 (9.68)	186.58(13.66)	-
SEm(±)	**0.34**	**0.62**	**0.54**	**0.59**	**1.08**	**0.49**	
LSD(0.05)	**0.69**	**1.26**	**1.10**	**1.19**	**1.78**	**1.19**	

Table 2: Effect of weed management treatments on the yield attribute, yield and economics (Average of two years)

Treatments	Average wt.(g)	No. of fruits per plant	Fruit yield(t ha^{-1})	Net returns(INR ha^{-1})	B:C ratio
T_1	57.0	09.53	19.98	3,26,290	4.44
T_2	60.1	11.02	21.79	3,75,153	5.01
T_3	59.2	10.59	21.08	3,47,490	4.68
T_4	39.9	05.77	7.87	83,966	1.14
T_5	54.4	07.59	15.25	2,30,870	3.10
T_6	50.0	07.08	13.09	1,87,988	2.54
T_7	58.2	08.81	18.97	3,01,076	3.83
T_8	58.3	09.34	20.52	3,31,877	4.22
T_9	59.1	10.64	23.22	3,82,196	4.63
T_{10}	29.5	06.73	7.34	74,440	1.02
SEm(±)	**0.84**	**0.33**	**0.83**		
LSD(0.05)	**2.51**	**0.99**	**1.69**	**-**	-

Note : *T_1=- Metribuzin @ 0.25kg ai ha^{-1}(PPI),T_2- Pendimethalin @1.5 kg ai ha^{-1}(PE) ,T_3- Fluchloralin@ 1.0 kg ai ha^{-1} (PPI) T_4- Metribuzin @0.25 kg ai ha^{-1} at 21 DAT, T_5- Pendimethalin @ 0.75 kg ai ha^{-1}(PE) + Metribuzin @ 0.15 kg ai ha^{-1} at 30 DAT,T_6- Fluchloralin @0.75 kg ai ha^{-1}(PPI) + Metribuzin @0.15kg ai ha^{-1} at 30DAT,T_7- Metribuzin @0.25 kg ai ha^{-1} + hand weeding at 30 DAT ,T_8- Pendimethalin @0.75 kg ai ha^{-1} (PE) + hand weeding at 30 DAT,T_9- Two hand weedings at 30 and 60 DAT,T_{10}- weedy check*

Effect on weeds

All the weed management treatments except application of metribuzin @0.25 kg ai ha^{-1} at 21 DAT (T_4), significantly reduced the weed density of both narrow and broadleaf weeds against weedy check (Table1). At both 30 DAT and harvest stage of observation application of herbicide pendimethalin @1.5 kg ha^{-1} as PE(T_2) effectively lowered the density of narrow and broad leaf weeds with dry matter accumulation of 3.22g sqm^{-1} at 30 DAT and 5.03g sqm^{-1} at harvest as compared to weedy check(T_{10}) recording 93.13 gm^{-1} at 30 DAT and 186.58g sqm^{-1} at harvest. However application of fluchloralin @ 1.0kg ai ha^{-1}as PPI (T_3) remained statistically *at par* with pendimethalin @1.5 kg ha^{-1}(PE) for the weed density count and dry matter accumulation (9.53 g sqm^{-1} at 30 DAT and 2.32g sqm^{-1} at harvest). The application of fluchloralin @ 1.0 kg ai ha^{-1}(PPI) gave highest weed control efficiency (98.5%) followed by pendimethalin @1.5 kg ai ha^{-1} at PE (97.5%) and this is attributed to lower weed density and dry matter accumulation through use of these herbicides. The treatment two hand weedings at 30 and 60 DAT(T_9) which although recorded appreciably high broad leaf count of at 46 sq m^{-1} when observed at 30 DAT but at harvest it reduced significantly (7.82 sq m^{-1}) compared to weedy check (242.33 sq m^{-1}) and consequently got reflected in a good weed control efficiency of 97.8%.

The integrated treatment of pendimethalin @0.75 kg ha^{-1} (PE)+ hand weeding at 30 DAT(T_8) also showed effective control the weeds with corresponding weed control efficiency of 95.5%. Although herbicide application of metribuzin @ 0.25 kg ai ha^{-1} at PE (T_1) and metribuzin @ 0.25 kg ai ha^{-1} (PE) + hand weeding at 30DAT (T_7) were not effective in controlling the narrow leaves weeds but the broad leaf weeds count was significantly reduced compared to weedy check treatment (T_{10}) and this got reflected on good weed control efficiency of 90.3% and 91.7 %, respectively.

Yield and yield attributes

All the weed management treatments except metribuzin @ 0.25 kg ai ha^{-1} at 21 DAT (T_4) resulted in improving the average fruit weight, number of fruits per plant and consequently the tomato yield and the profits over the untreated check (Table 2). Application of metribuzin @ 0.25 kg ai ha^{-1} at 21 DAT being poor in curbing the weeds was reflected in lowest yield (7.87 t ha^{-1}) among all weed management treatments which was comparable with weedy check (7.34 t ha^{-1}). Application of herbicide pendimethalin @ 1.5 kg ai ha^{-1} (T_2), fluchloralin @ 1.0 kg ai ha^{-1}(T_3) and two hand weeding at 30 and 60 DAT (T_9) being statistically at par with each other for average fruit weight, number of fruits per plant, consequently gave fruit yield of 21.80, 21.08 and 23.23 t ha^{-1}, respectively which were significantly superior over other weed management treatments. The per cent increase in yield from T_2, T_3 and T_9 over the weedy check (T_{10}) was 195.4, 187.2 and 216.5 per cent, respectively. These higher yields in these treatments are attributed to higher weed control efficiency from these weed management practices. However fruit yields of 19.99 t ha^{-1} from weed management through application of metribuzin @ 0.25 kg ai ha^{-1} (T_1) and 20.53 t ha^{-1} with application of pendimethalin@ 0.75kg ai ha^{-1} + hand weeding at 30 DAT (T_8) remained statistically at par with treatments T_2 and T_3. Effective weed control and increase in yields with application of fluchloralin @1.0 kg ai ha^{-1} (Behera and Singh, 1999) and metribuzin (Hesammi, 2013) have been reported.

The production economics varied with different weed management treatments applied in crop (Table2) .Among all the weed management treatments the lowest net returns (INR 83,966) and B: C ratio (1.14) was obtained when herbicide metribuzin @ 0.25 kg ai ha^{-1} at 21 DAT (T_4) was applied and this was as near as weedy check with net returns of INR 74,440 and B: C ratio (1.02). The highest net returns of INR 3,82,196 and B:C ratio (4.63) was obtained under two hand weedings application at 30 and 60 DAT (T_9) and this was closely followed by treatment (T_2) pendimethalin @ 1.0 kg ai ha^{-1} (INR 3,75,153 and B:C ratio (5.01) and (T_3) fluchloralin @ 1.0 kg ai ha^{-1} (INR 3,47,490 and B:C ratio of 4.68).

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