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Weed Dynamics, Productivity and Profitability of Green Chilli as Influenced by Different Weed Control Measures

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A B S T R A C T

A field experiment on weed dynamics, productivity and profitability of green chilli as influenced by different weed control measures was conducted in two consecutive *rabi* seasons of 2012 and 2013 in a randomized complete block design with ten treatments [Propaquizafop 10% EC PoE (postemergence) @ 500 ml ha^{-1} (50 g a.i.), Propaquizafop 10% EC PoE @ 625 ml ha^{-1} (62.5 g a.i.), Propaquizafop 10% EC PoE @ 750 ml ha^{-1} (75 g a.i.), Propaquizafop 10% EC PoE @ 1250 ml ha^{-1} (125 g a.i.), Pendimethalin 30% EC PRE (preemergence) @ 4160 ml ha^{-1} (1250 g a.i.), Pendimethalin 30% EC PRE @ 4160 ml ha^{-1} (1250 g a.i.) -1 IC at 30 DAT, Propaquizafop 10% EC PoE @ 625 ml ha^{-1} (62.5 g a.i.) fb (followed by) 1 intercultivation at 30 DAT, Pendimethalin 30% EC PRE @ 4160 ml ha^{-1} (1250 g a.i.) fb 10% EC PoE @ 625 ml ha^{-1} (62.5 g a.i.) at 2-7 leaf stage, weedy check and control (Hand weeding)] at Raichur in Hyderabad Karnataka region. The predominant weed flora were *Dinebra retroflexa, Panicum flavidum, Panicum javanicum, Brachiaria reptans, Cynondon dactylon* among monocots*; Cyperus rotundus* among sedge *and Trianthema portulacastrum, Digeria aravensis, Amaranthus polygamus, Amaranthus viridis, Parthenium hysterophorus, Euphorbia hirta, Phyllannthus maderaspatensis, Portulaca oleracea, Sida acuta* and *Celosia argenstia* among dicots. All the weed control treatments resulted significant reduction in weed growth in terms of density and dry weight as compared to weedy check. Significantly lower weed population and dry weight of weeds was recorded with thrice hand weeding at 35, 50 and 65 days after transplanting (DAT). Among herbicides, it was lowest with Pendimethalin 30% EC PRE @ 4160 ml ha^{-1} (1250 g a.i.) -1 IC at 30 DAT and pendimethalin 30% EC PRE @ 4160 ml ha^{-1} (1250 g a.i.) propaquizafop 10% EC PoE @ 625 ml $ha^{-1}$and propaquizafop 10% EC PoE @ 1250 ml ha^{-1}. The maximum green chilli yield (22.0 t ha^{-1}) was recorded three hand weedings at 35, 50 and 65 DAT and lowest green chilli yield was recorded with weedy check (12.1 t ha^{-1}). Maximum benefit cost ratio was recorded with pre emergence application of pendimethalin 30% EC @ 4160 ml ha^{-1} (1250 g a.i.) followed by Propaquizafop 10% EC @ 625 ml ml (62.5 g a.i.) ha^{-1} (2.46).

Introduction

Chilli, claimed as red gold, is one of the important spices as well as vegetable crops of the country grown over an area of 37,958 ha with a production of 5.54 lakh tonnes with a productivity of 14.59 t ha^{-1} in Karnataka (Anon, 2012). In Hyderabad Karnataka region especially, TBP and UKP irrigation commands of state crop is cultivated on large area under irrigation much of which finds its way to Kerala market for export and export

potential is the main attraction for cultivated by farmers. Average yield under irrigation is 12-16 t acre^{-1} in this part of the state.

There are several constraints in chilli production. Weed infestation is one of the major factors for loss in yield under irrigated conditions as chilli is usually planted at wider spacing and it grows very slowly during early growth stages. Weeds which emerge and become established during early stages of chilli growth can be very competitive and reduce the chilli yield potential significantly. The extent of yield reduction caused by weeds vary from 30 to 80 % depending on type of weeds, season, variety, soil type, rainfall, duration and time of weed competition.

The conventional methods of weed control (hoeing and hand weeding) are laborious, expensive and insufficient. Moreover, weeding during critical growth stages is very difficult due to increased cost of human labours and its scarce availability. On, the other hand, use of herbicides alone does not prove effective for weed control due to their spectrum of weed kill and also the prolonged and indiscriminate use of recommended herbicides is observed to result in increased accumulation of their residues in soil with negative impact on crop growth factors and resulted in weed shift in some areas. Hence, an attempt was made to find out the appropriate combination of cultural and chemical weed management practices for weed control in chilli, which is practically effective and economically feasible for farmers.

Materials and Methods

A field experiment was conducted during two consecutive *rabi* seasons of years of 2012 and 2013 at Main Agricultural Research Station Farm, University of Agricultural Sciences, Raichur in Hyderabad Karnataka region in chilli. The experimental site was coming under North Eastern Dry Zone (Zone -II) of Karnataka and situated at 16° 15' N latitude 77° 20' E longitude and altitude of 389 m above mean sea level. The soil was clayey with alkaline pH (8.00) having 0.75% OC, 269.0 kg ha^{-1} available N, 17.75 kg ha^{-1} available P_2O_5 and 458.40 kg ha^{-1} K_2O. The study was conducted to know the bio-efficacy and selectivity of different herbicides for weed control in chilli. An experiment comprising ten treatments *viz*. Propaquizafop 10% EC PoE (postemergence) @ 500 ml per ha (T_1: 50 g a.i.), Propaquizafop 10% EC PoE @ 625 ml ha^{-1} (T_2:62.5 g a.i.), Propaquizafop 10% EC PoE @ 750 ml ha^{-1} (T_3:75 g a.i.), Propaquizafop 10% EC PoE @ 1250 ml ha^{-1} (T_4:125 g a.i.), Pendimethalin 30% EC PRE (preemergence) @ 4160 ml ha^{-1} (T_5: 1250 g a.i.), Pendimethalin 30% EC PRE @ 4160 ml ha^{-1} (1250 g a.i.) -1 IC at 30 DAT (T_6), Propaquizafop 10% EC PoE @ 625 ml ha^{-1} (62.5 g a.i.) fb (followed by) 1 intercultivation (IC) at 30 DAT (T_7), Pendimethalin 30% EC PRE @ 4160 ml ha^{-1} (1250 g a.i.) fb T_2 at 2-7 leaf stage (T_8), weedy check (T_9) and control (T_{10}: Hand weeding) laid out in Randomized complete block design (RCBD) with three replications.

The 45 days old seedlings of chilli were transplanted in the month of November and September during 2012 and 2013, respectively at a spacing of 75 cm X 45 cm and the recommended package of practices was performed during the crop period as per need. Pre-emergent (PRE) application of pendimethalin 30% EC was carried out on the day of transplanting and post emergent (PoE) spray of propaquizafop 10% EC was applied at 2-7 leaf stage of weed (20 days after transplanting). Data on weed population species wise were recorded at pretreatment, 15, 30 and 45 days after spraying using quadrants of 0.5 m x 0.5 m, and likewise weed dry weight was recorded. Weed control efficiency (WCE) was worked out taking weed count into consideration. Further, data

on weed density and dry weight was subjected to square root transformation before analysis.

The observation on phyto-toxicity of the chemical at higher dosages was also recorded separately. The field experiment was laid out in Randomized Block Design with prescribed treatments. The observation of phyto-toxicity on chilli and fodder cowpea plants were done on the basis of phytotoxicity rating scale (PRS) for the applied testing herbicide Propaquizafop 10% EC at 1, 3, 5, 7 and 10 DAA. The parameters on phytotoxicity were taken as vein clearing, leaf epinasty and hyponasty, necrosis (leaf tips and margins) and wilting. The observation on the level of phytotoxicity through visual assessment of crop response was rated in the scale of 0-10 (0 = No adverse effect of herbicide on cotton and 10= 100% adverse effect of herbicide on cotton).

Data on growth attributes were recorded from 5 randomly selected plants, whereas yield attributes and yield data recorded from net plot at harvest. For economic study prevailing market price was used for different outputs and inputs. The similar trend of results was observed during 2012 and 2013 for all the characters. Hence, the pooled analysis was done for the results. All the parameters were subjected for statistical analysis and interpretation as outlined by Panse and Sukhatme (1967).

Results and Discussion

Effect on weeds

The prominent weed species in the experimental plot were *Dinebra retroflexa, Panicum flavidum, Panicum javanicum, Brachiaria reptans, Cynondon dactylon* among monocots; *Cyperus rotundus* among sedge and *Trianthema portulacastrum, Digeria aravensis, Amaranthus polygamus, Amaranthus viridis, Parthenium hysterophorus, Euphorbia hirta, Phyllannthus maderaspatensis, Portulaca oleracea, Sida acuta* and *Celosia argenstia* among dicot weeds etc. These results are in line with Gare *et al.,* (2015) and Shruthi and Salakinkop (2015). All the weed control treatments showed significant reduction in weed growth in terms of density and dry weight as compared to weedy check (Tables 1 & 2). Among the different treatments, hand weeding thrice at 35, 50 and 65 days after transplanting (DAT) recorded lowest density and dry weight of weeds (12.76 m^{-2} and 20.02 g m^{-2}, respectively) followed by pendimethalin 30% EC PRE @ 4160 ml ha^{-1} (1250 g a.i.) fb one IC at 30 DAT (17.51 m^{-2}) w.r.t. to density and pendimethalin 30% EC PRE @ 4160 ml ha^{-1} (1250 g a.i.) fb propaquizafop 10% EC PoE @ 625 ml ha^{-1} (23.91g m^{-2}) with respect to dry weight. Among the herbicidal treatments, the latter treatment i.e. pendimethalin 30% EC PRE @ 4160 ml ha^{-1} (1250 g a.i.) fb one IC at 30 DAT recorded least number of weeds and it was on par with pendimethalin 30% EC PRE @ 4160 ml ha^{-1} (1250 g a.i.) fb propaquizafop 10% EC PoE @ 625 ml ha^{-1} (62.5 g a.i.) resulted in effective control of composite weed flora, thereby reduced the dry weight of weeds at 45 days after spraying. These results are also in accordance with those of Hassan and Ahmad (2005), Abid Khan *et al.,* (2012) and Gare *et al.,* (2015) who also found highest number of weeds and dry weight of weeds m^{-2} in weedy check plots and lowest in hand weeded treatments.

Hand weeding thrice at 35, 50 and 65 DAT recorded higher weed control efficiency (WCE) at 45 days after spraying (87.97 %) followed by the integrated treatment of pendimethalin 30% EC PRE @ 4160 ml ha^{-1} (1250 g a.i.) fb one IC at 30 DAT (83.47%) and it was on par with pendimethalin 30% EC PRE @ 4160 ml ha^{-1} (1250 g a.i.) fb propaquizafop 10% EC @ 625 (62.5 g a.i.) ml ha^{-1} (82.20%) over other treatments (Table 3).

Table.1 Effect of Propaquizafop 10% EC and other treatments on density of grassy weeds at different stages in chilli (Average of two years)

Treatments	Density of weeds (No. m^{-2})															
	Grasses				Sedges				Broad leaved				Total			
	BS	15 DAS	30 DAS	45 DAS	BS	15 DAS	30 DAS	45 DAS	BS	15 DAS	30 DAS	45 DAS	BS	15 DAS	30 DAS	45 DAS
T_1	6.25 (38.80)	5.32 (28.00)	4.44 (19.50)	3.74 (13.76)	1.95 (3.53)	1.71 (2.67)	1.58 (2.25)	1.61 (2.33)	6.18 (38.00)	6.40 (40.67)	6.54 (42.50)	6.51 (42.17)	8.98 (80.33)	8.46 (71.33)	8.03 (64.25)	7.65 (58.26)
T_2	6.58 (43.05)	5.26 (27.41)	4.14 (16.92)	3.57 (12.47)	1.91 (3.38)	1.53 (2.10)	1.41 (1.75)	1.43 (1.79)	6.16 (37.67)	6.32 (39.67)	6.41 (40.83)	6.44 (41.17)	9.18 (84.10)	8.33 (69.18)	7.73 (59.50)	7.76 (55.43)
T_3	6.73 (45.02)	5.28 (27.67)	3.94 (15.29)	3.26 (10.40)	1.83 (3.10)	1.51 (2.02)	1.37 (1.63)	1.40 (1.71)	6.24 (38.67)	6.33 (39.83)	6.42 (41.00)	6.42 (41.00)	9.33 (86.78)	8.35 (69.52)	7.63 (57.93)	7.30 (53.11)
T_4	6.42 (40.97)	4.84 (23.18)	3.73 (13.63)	3.05 (9.06)	1.64 (2.45)	1.41 (1.73)	1.34 (1.54)	1.37 (1.63)	6.10 (37.00)	6.42 (41.00)	6.49 (41.83)	6.45 (41.33)	8.98 (80.42)	8.13 (65.90)	7.57 (57.01)	7.23 (52.02)
T_5	4.08 (16.37)	3.54 (12.26)	3.73 (13.63)	3.32 (10.78)	1.60 (2.30)	1.44 (1.83)	1.37 (1.63)	1.34 (1.54)	3.40 (11.33)	3.35 (11.00)	3.23 (10.17)	3.18 (9.83)	5.50 (30.00)	5.03 (25.09)	4.78 (22.57)	4.73 (22.16)
T_6	4.17 (17.12)	3.23 (10.18)	2.78 (7.47)	2.71 (7.09)	1.45 (1.85)	1.30 (1.44)	1.20 (1.20)	1.15 (1.08)	3.48 (11.83)	3.07 (9.17)	3.01 (8.83)	3.10 (9.33)	5.57 (30.80)	4.59 (20.79)	4.21 (17.50)	4.21 (17.51)
T_7	6.30 (39.42)	3.86 (14.65)	3.15 (9.69)	2.87 (7.97)	1.66 (2.50)	1.41 (1.75)	1.35 (1.58)	1.26 (1.33)	5.16 (26.33)	4.01 (15.83)	3.82 (14.33)	3.48 (14.33)	8.28 (68.25)	5.70 (32.23)	5.09 (25.61)	4.89 (23.63)
T_8	4.16 (17.05)	3.18 (9.83)	2.68 (6.91)	2.48 (5.89)	1.46 (1.88)	1.32 (1.50)	1.26 (1.33)	1.17 (1.13)	3.40 (11.33)	3.55 (12.33)	2.93 (8.33)	3.48 (11.83)	5.52 (30.27)	4.89 (23.67)	4.10 (16.58)	4.37 (18.86)
T_9	6.75 (45.25)	7.32 (53.39)	7.66 (58.42)	7.67 (58.58)	1.58 (2.25)	1.80 (3.00)	1.85 (3.17)	1.91 (3.42)	6.17 (37.83)	6.45 (41.33)	6.61 (43.50)	6.65 (44.00)	9.25 (85.33)	9.90 (97.73)	10.26 (105.08)	10.31 (106.00)
T_{10}	4.37 (18.87)	3.23 (10.21)	2.20 (4.58)	2.13 (4.30)	1.48 (1.95)	1.40 (1.72)	1.08 (0.93)	1.17 (1.13)	3.64 (13.00)	3.28 (10.50)	2.63 (6.67)	2.75 (7.33)	5.84 (33.85)	4.76 (22.43)	3.52 (12.18)	3.61 (12.76)
S.Em+	**0.16**	**0.15**	**0.13**	**0.11**	**0.06**	**0.07**	**0.06**	**0.06**	**0.23**	**0.18**	**0.15**	**0.13**	**0.18**	**0.16**	**0.15**	**0.12**
C.D@ 5%	**0.47**	**0.44**	**0.40**	**0.33**	**0.17**	**0.22**	**0.19**	**0.18**	**0.68**	**0.53**	**0.46**	**0.40**	**0.53**	**0.49**	**0.46**	**0.35**
CV (%)	**6.94**	**8.05**	**8.66**	**7.70**	**8.45**	**11.92**	**11.38**	**10.91**	**11.16**	**8.85**	**7.76**	**6.62**	**5.65**	**5.91**	**5.99**	**4.60**

Note:

T_1: Propaquizafop 10% EC @ 500 ml ha^{-1} (50 g a.i.) T_2: Propaquizafop 10% EC @ 625 ml ha^{-1} (62.5 g a.i.) T_3: Propaquizafop 10% EC @ 750 ml ha^{-1} (75 g a.i.)

T_4: Propaquizafop 10% EC @ 1250 ml ha^{-1} (125 g a.i.) T_5: Pendimethalin 30% EC @ 4160 ml ha^{-1} (1250 g a.i.) T_6: Pendimethalin 30% EC @ 4160 ml ha^{-1} (1250 g a.i.) -1 IC at 30 DAT

T_7: Propaquizafop 10% EC @ 625 ml ha^{-1} (62.5 g a.i.) - 1 IC at 30 DAT T_8: Pendimethalin 30% EC @ 4160 ml ha^{-1} (1250 g a.i.) - T_2 at 2-7 leaf stage T_9: Weedy check T_{10}: Control (Hand weeding)

DAT- Days after transplanting, IC- Intercultivation, DAS- Days after spraying, BS- Before spraying, figures in parenthesis indicates original values and outside are transformed values [square root of (X+1)]

Table.2 Effect of Propaquizafop 10% EC and other treatments on weed dry weight at different growth stages in chilli (Average of two years)

Treatments	Weed dry weight (g m^{-2})							
	At 30 days after spraying				At 45 days after spraying			
	Grasses	Sedges	BLW	Total	Grasses	Sedges	BLW	Total
T_1: Propaquizafop 10% EC @ 500 ml ha^{-1} (50 g a.i.)	5.39 (28.85)	1.84 (3.13)	7.60 (57.48)	9.47 (89.46)	5.43 (29.26)	1.81 (3.04)	7.95 (63.02)	9.78 (95.32)
T_2: Propaquizafop 10% EC @ 625 ml ha^{-1} (62.5 g a.i.)	5.02 (25.00)	1.65 (2.46)	7.56 (56.85)	9.20 (84.31)	4.96 (24.36)	1.66 (2.50)	7.88 (61.83)	9.43 (88.69)
T_3: Propaquizafop 10% EC @ 750 ml ha^{-1} (75 g a.i.)	4.74 (22.26)	1.58 (2.23)	7.53 (56.39)	9.01 (80.89)	4.71 (21.94)	1.64 (2.43)	7.96 (63.19)	9.37 (87.55)
T_4: Propaquizafop 10% EC @ 1250 ml ha^{-1} (125 g a.i.)	4.59 (20.80)	1.55 (2.15)	7.55 (56.79)	8.94 (79.73)	4.14 (16.88)	1.54 (2.12)	7.84 (61.29)	8.97 (80.29)
T_5: Pendimethalin 30% EC @ 4160 ml ha^{-1} (1250 g a.i.)	4.08 (16.36)	1.58 (2.24)	3.72 (13.57)	5.69 (32.17)	4.48 (19.84)	1.50 (2.01)	4.00 (15.76)	6.15 (37.61)
T_6: Pendimethalin 30% EC @ 4160 ml ha^{-1} (1250 g a.i.) -1 IC at 30 DAT	3.26 (10.36)	1.36 (1.60)	3.45 (11.67)	4.89 (23.63)	3.58 (12.59)	1.38 (1.66)	3.81 (14.23)	5.36 (28.48)
T_7: Propaquizafop 10% EC @ 625 ml ha^{-1} (62.5 g a.i.) - 1 IC at 30 DAT	3.72 (13.60)	1.50 (1.99)	4.40 (19.10)	5.91 (34.69)	3.85 (14.55)	1.39 (1.68)	4.69 (21.70)	6.18 (37.93)
T_8: Pendimethalin 30% EC @ 4160 ml ha^{-1} (1250 g a.i.) - T_2 at 2-7 leaf stage	3.10 (9.38)	1.35 (1.56)	3.87 (14.75)	5.09 (25.69)	3.06 (9.13)	1.37 (1.62)	3.66 (13.17)	4.92 (23.91)
T_9: Weedy check	7.28 (52.72)	2.06 (4.01)	7.72 (59.30)	10.78 (116.03)	7.19 (51.51)	2.16 (4.43)	8.04 (64.37)	10.98 (120.31)
T_{10}: Control (Hand weeding)	2.89 (8.12)	1.23 (1.27)	3.16 (9.71)	4.40 (19.10)	2.71 (7.08)	1.25 (1.32)	3.45 (11.63)	4.50 (20.02)
S.Em±	**0.18**	**0.05**	**0.15**	**0.17**	**0.15**	**0.09**	**0.16**	**0.17**
C.D@ 5%	**0.55**	**0.15**	**0.45**	**0.50**	**0.44**	**0.26**	**0.49**	**0.50**
CV (%)	**10.17**	**8.07**	**6.50**	**5.52**	**8.10**	**13.42**	**6.78**	**5.40**

Note: DAT- Days after transplanting, IC- Intercultivation, DAS- Days after spraying, BS- Before spraying, Figures in parenthesis indicates original values and outside are transformed values [square root of (X+1)]

Table.3 Effect of Propaquizafop 10% EC and other treatments on weed control efficiency (%) at different growth stages in chilli (Average of two years)

Treatments	Weed control efficiency (%)							
	At 30 days after spraying				At 45 days after spraying			
	Grasses	Sedges	BLW	Total	Grasses	Sedges	BLW	Total
T_1: Propaquizafop 10% EC @ 500 ml ha^{-1} (50 g a.i.)	66.33	27.78	2.00	31.35	76.53	30.75	4.05	35.10
T_2: Propaquizafop 10% EC @ 625 ml ha^{-1} (62.5 g a.i.)	71.05	44.44	5.95	43.32	78.71	46.68	6.32	47.69
T_3: Propaquizafop 10% EC @ 750 ml ha^{-1} (75 g a.i.)	73.74	46.94	5.48	44.75	82.24	48.61	6.72	49.89
T_4: Propaquizafop 10% EC @ 1250 ml ha^{-1} (125 g a.i.)	76.61	50.00	3.35	45.49	84.54	51.59	6.11	50.93
T_5: Pendimethalin 30% EC @ 4160 ml ha^{-1} (1250 g a.i.)	81.51	47.64	76.57	78.47	81.58	54.17	77.64	79.10
T_6: Pendimethalin 30% EC @ 4160 ml ha^{-1} (1250 g a.i.) -1 IC at 30 DAT	87.22	62.08	79.60	83.32	87.88	67.86	78.80	83.47
T_7: Propaquizafop 10% EC @ 625 ml ha^{-1} (62.5 g a.i.) - 1 IC at 30 DAT	83.31	49.31	66.88	75.53	86.39	59.44	67.54	77.72
T_8: Pendimethalin 30% EC @ 4160 ml ha^{-1} (1250 g a.i.) - T_2 at 2-7 leaf stage	88.23	57.64	80.77	84.22	89.90	66.35	73.10	82.20
T_9: Weedy check	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
T_{10}: Control (Hand weeding)	92.15	70.28	84.68	88.41	92.67	65.72	83.36	87.97
S.Em±	**1.81**	**5.89**	**4.07**	**2.27**	**1.11**	**4.54**	**3.06**	**2.36**
C.D@ 5%	**5.42**	**17.66**	**12.21**	**6.81**	**3.33**	**13.60**	**9.18**	**7.07**
CV (%)	**6.15**	**31.62**	**24.62**	**9.67**	**3.58**	**22.62**	**18.59**	**9.73**

Note: DAT- Days after transplanting, IC- Intercultivation, DAS- Days after spraying and BLW- Broad leaved weeds

Table.4 Ancillary characters, yield and economics of chilli as influenced by different weed control treatments (Average of two years)

Treatments	Ancillary characters and yield				Economics			
	Plant height (cm)	No of branches	Yield (kg/plot)	Yield (t/ha)	Cost of Cultivation	Gross returns	Net returns	B:C
					Rs. ha^{-1}			
T_1: Propaquizafop 10% EC @ 500 ml ha^{-1} (50 g a.i.)	80.7	15.9	16.8	16.6	69416	140958	71542	2.03
T_2: Propaquizafop 10% EC @ 625 ml ha^{-1} (62.5 g a.i.)	81.8	16.4	17.2	17.0	69738	144075	74338	2.08
T_3: Propaquizafop 10% EC @ 750 ml ha^{-1} (75 g a.i.)	82.3	16.9	17.4	17.2	70059	146200	76141	2.08
T_4: Propaquizafop 10% EC @ 1250 ml ha^{-1} (125 g a.i.)	82.6	17.1	17.8	17.5	71072	149033	77961	2.12
T_5: Pendimethalin 30% EC @ 4160 ml ha^{-1} (1250 g a.i.)	85.6	18.3	19.4	19.2	71425	163200	91775	2.28
T_6: Pendimethalin 30% EC @ 4160 ml ha^{-1} (1250 g a.i.) -1 IC at 30 DAT	85.9	19.5	20.5	20.3	76329	172125	95796	2.26
T_7: Propaquizafop 10% EC @ 625 ml ha^{-1} (62.5 g a.i.) - 1 IC at 30 DAT	84.4	18.5	18.6	18.4	74848	155975	81127	2.08
T_8: Pendimethalin 30% EC @ 4160 ml ha^{-1} (1250 g a.i.) - T_2 at 2-7 leaf stage	86.1	20.1	21.5	21.2	73379	180483	107104	2.46
T_9: Weedy check	65.0	14.5	12.3	12.1	63899	102850	38951	1.61
T_{10}: Control (Hand weeding)	86.7	21.5	22.4	22.0	80053	187283	107230	2.34
S.Em±	**2.30**	**1.09**	**1.24**	**1.22**	**1349**	**10391**	**10438**	**0.15**
C.D@ 5%	**6.89**	**3.26**	**3.70**	**3.67**	**4043**	**31153**	**31293**	**0.45**
CV (%)	**6.86**	**14.90**	**16.47**	**16.50**	**4.59**	**16.50**	**21.10**	**17.09**

Note: DAT- Days after transplanting, IC- Intercultivation, DAS- Days after spraying, B:C- Benefit-cost ratio, Men and women labour @ Rs. 236 each, FYM @Rs. 600 kg^{-1}, Urea @Rs. 5.72 kg^{-1}, DAP @Rs. 25.32 kg^{-1}, MoP @Rs. 18.22 kg^{-1}, Pegasus 500 SC @ Rs. 3868 kg^{-1}, Chloropyriphos @ Rs. 480 l^{-1}, Spinosad @Rs.1250 per 75ml and Green chilli @ Rs 8.50 kg^{-1}.

The results are analogous to those reported by Arvadiya *et al.*, (2012), Kalhapure *et al.*, (2013) and Gare *et al.*, (2015).

Phytotoxicity on chilli and succeeding crop

The application of different treatments pendimethalin 30% EC PRE @ 4160 ml ha^{-1} (1250 g a.i.), propaquizafop 10% EC PoE @ 625 ml $ha^{-1}$and propaquizafop 10% EC PoE @ 1250 ml ha^{-1} has not recorded any phyto-toxicity on chilli crop. After the harvest of chilli, fodder cowpea was grown to evaluate the herbicide carry over effect.

Observations on germination, plant height and phyto-toxicity was recorded on succeeding fodder cowpea in those plots where different treatments of Pendimethalin 30% EC and Propaquizafop 10% EC was applied on Chilli crop in the previous season and data indicates no adverse effect of Propaquizafop 10 % EC treatment on cowpea as there was no significant difference on germination, plant height as well as no phyto-toxic symptoms like epinasty, hyponasty, necrosis, wilting and vein clearing were observed on cowpea crop. The yield data also did not vary significantly among the treatments.

Effect on crop growth and yield attributes

In general, all weed control treatments had marked improvement on growth and yield attributes and green chilli yield. Significantly taller plants (86.7 cm), more number of branches (21.5) and maximum green chilli yield (22.0 t ha^{-1}) was recorded with hand weedings three at 35, 50 and 65 DAT (Table 4) and it was on par with pendimethalin 30% EC PRE @ 4160 ml ha^{-1} (1250 g a.i.) fb propaquizafop 10% EC PoE @ 625 ml ha^{-1} (86.1 cm, 20.1 and 21.5 t ha^{-1}, respectively) and pendimethalin 30% EC PRE @ 4160 ml ha^{-1} (1250 g a.i.) fb one IC at 30 DAT (85.9cm, 19.5 and 20.5 t ha^{-1}, respectively) while the lowest was recorded with weedy check (65cm, 14.5 and 12.3 t ha^{-1}, respectively). This could be attributed to suppression of weeds by pre and post emergence herbicide application and inturn reduced soil moisture and nutrient losses due to weeds and making available to chiili crop.

These finding are in agreement with the results of Deshpande *et al.*, (2006), Kunti and Singh (2012) and Gare *et al.*, (2015).

Economics

Economic evaluation of weed control measures indicated that hand weeding thrice at 35, 50 and 65 DAT recorded significantly higher gross returns (Rs. 1,87,283 ha^{-1}) over weedy check (Rs. 1,02,850). Significantly highest net returns and benefit cost ratio (Rs. 1,07,104 ha^{-1} and 2.46, respectively) was recorded with pendimethalin 30% EC PRE @ 4160 ml ha^{-1} (1250 g a.i.) fb propaquizafop 10% EC PoE @ 625 ml ha^{-1} and it was on par with that thrice hand weeding at 35, 50 and 65 DAT (Rs. 1, 07,230 ha^{-1} and 2.34) and pendimethalin 30% EC PRE @ 4160 ml ha^{-1} (1250 g a.i.) fb one IC at 30 DAT (Rs. 95,796 and 2.26, respectively). The improved monitory returns were attributed to higher green chilli yield as a consequence of effective weed management methods. Similar results are obtained by Gare *et al.*, (2015).

On the basis of two years experimentation, it was concluded that application of pendimethalin 30% EC PRE @ 4160 ml ha^{-1} (1250 g a.i.) fb propaquizafop 10% EC PoE at 2-7 leaf stage of weeds @ 625 ml ha^{-1} (62.5 g a.i.) and pendimethalin 30% EC PRE @ 4160 ml ha^{-1} (1250 g a.i.) fb one IC at 30 DAT in the labour scarce area instead of thrice hand weeding at at 35, 50 and 65 days after transplanting was more efficient, practically convenient and economically feasible method of weed control.

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