Bio-efficacy of herbicides on weed density, weed control efficiency, productivity and quality in groundnut under rice-groundnut system in coastal zone of Karnataka

ABSTRACT

A field experiment was conducted to study the "bio-efficacy of herbicides on weed control efficiency and productivity in groundnut under rice-groundnut system in coastal zone of Karnataka" at Agricultural Research Station, Kumta, Uttara Kannada district during *rabi*-summer 2016-17. The experiment was layout in a randomized block design with nine treatments involving six treatments with pre-emergence application of herbicides followed by hand weeding or early post-emergence application in sequence along with control treatments. The results revealed that, pre-emergence application of pendimethalin 30 % E.C. @ 1.5 kg ha^{-1} followed by one hand weeding at 25 DAS recorded significantly lowered total weed density, weed dry matter, higher weed control efficiency with lower weed index and further higher pod yield, kernel yield and quality of groundnut as compared to other treatments.

Key words: Herbicides, Groundnut, Weed control efficiency,Quality, Yield

INTRODUCTION

In India, groundnut is being cultivated over an area of 8.59 million hectares witha total production of 6.56 million tonnes with productivity of 1,764 kg ha^{-1} (Anonymous,2015). Major groundnut growing states *viz.*, Gujarat, Andhra Pradesh, Tamil Nadu,Rajasthan, Karnataka and Maharashtra, which contribute 90 per cent of total groundnutproduction. Karnataka ranks fifth in the country with a production of 0.56 milliontonnes from an area of 0.82 million hectares and an average yield of 907 kg ha^{-1} (Anonymous,2015). This is very low when compared to the national productivity. The major groundnut growing districts in *rabi* season in Karnataka are Udupi and Uttara kannada. To meet the growing demand of oilseed production the groundnut cultivation has been extended to *rabi*/summer or post rainy season in Andhra Pradesh, Tamil Nadu, Orissa, Kerala, West Bengal, Karnataka and Jharkhand, where in most of the land remains fallow after *kharif* rice. Cultivation of pulses (green gram and black gram) in rice-fallow is a common practice in coastal areas of Andhra Pradesh, Karnataka and Tamil Nadu. Groundnut is one of the alternatives to these pulses in rice-fallows under coastal areas.

Weed infestation is one of the key factors. During the early stages of crop growth, it encounters severe weed problem, because of slow growth of crop in the initial stages. Moreover shoot growth is very less when compared to the root development. The weeds emerge fast and grow rapidly competing with the crop severely for the resources *viz.*, nutrients, light, and also transpire lot of water from the soil. The initial four to eight weeks after sowing are considered as the critical period of weed competition during the crop growth period (Jat*et al.,* 2011). On an average the loss of groundnut production in the country due to weeds has been estimated to the tune of 15 to 75 per cent (Sathya *et al.,* 2013). Chemical method of weed management forms an excellent alternative to manual and mechanical weed control methods. Further, lack of pre-emergence herbicide activity for longer period's results in weed growth that necessitate hand weeding at 25-40 days after sowing. In such situation post-emergence herbicides (Imazethapyr and Quizalofop-p-ethyl) were suggested for weed management at critical weed stage. Development of suitable weed management strategies to alleviate weed pressure on the available resources is known to prop up the crop productivity considerably. Hence there is a need to study the bio-efficacy of herbicides on weed density, weed control efficiency, productivity and quality in groundnut under rice-groundnut system in coastal zone of Karnataka.

MATERIALS AND METHODS

A field experiment was conducted to study the "Bio-efficacy of herbicides on weed management in groundnut under rice-groundnut system in coastal zone of Karnataka" at Agricultural Research Station, Kumta, Uttar Kannada, University of Agricultural Sciences, Dharwad (Karnataka) during *rabi*-summer 2016-17.The experiment was laidout in a Randomized Block Design having nine treatments with three replications. Treatment details such as., $T_{1:}$Unweeded check, $T_{2:}$ Weed free check, $T_{3:}$ Two hand weeding (At 20 and 40 DAS), $_{4:}$ pendimethalin 30 % E.C. @ 1.5 kg ha^{-1} (PE) *fb* one hand weeding at 25 DAS, $T_{5:}$ oxyfluorfen 23.5 % E.C. @ 200 g ha^{-1}(PE) *fb* one hand weeding at 25 DAS, T_6: pendimethalin 30 % E.C. @ 1.5 kg ha^{-1} (PE) *fb* quizalofop-p-ethyl 5 % E.C. @ 50 g ha^{-1} 20-30 DAS (POE), $T_{7:}$ pendimethalin 30 % E.C. @ 1.5 k ha^{-1} (PE) *fb* imazethapyr 10 % S.L. @ 75 g ha^{-1} 20- 30 DAS (POE), $T_{8:}$ pendimethalin 30 % E.C. @ 1.5 kg ha^{-1} (PE) *fb* oxyfluorfen 23.5 % E.C. @ 100 g ha^{-1} at 20-30 DAS (POE) and T_9: pendimethalin 30 % E.C. @ 1.0 kg ha^{-1} (PE) *fb* one hand weeding at 25 DAS. At 20, 25 and 40 days after sowing hand weeding were done as per treatment. In weed free treatment, throught the crop growth period weed free condition was maintained as when weeds emerged.Observations on weed density, weed

dry matter, weed control efficiency and weed index were calculated as per treatments. Similarly plant observations were taken at harvest.

For analysis of weed density and dry matter, corresponding transformed values ($\sqrt{x+1}$) were used for statistical analysis as suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Influence of bio-efficacy of herbicides on weed density

Among the weed management treatments, the lowest total weed density (18.33 m^{-2}), (15.67 m^{-2}), (19.33 m^{-2}) and (14.33 m^{-2}) at 20, 40, 60 DAS and at harvest recorded with T_4*i.e.*, pre-emergence application of pendimethalin 30 % E.C. @ 1.5 kg ha^{-1} followed by one hand weeding at 25 DAS, and which was on par with T_5:oxyfluorfen 23.5 % E.C. @ 200 g ha^{-1} *fb* one hand weeding at 25 DAS, T_6: pendimethalin 30 % E.C. @ 1.5 kg ha^{-1} *fb* quizalofop-p-ethyl 5 % E.C. @ 50 g ha^{-1} 20-30 DAS, T_7: pendimethalin 30 % E.C. @ 1.5 kgha^{-1} imazethapyr 10 % S.L. @ 75 g ha^{-1} at 20-30 DAS, and T_8: pendimethalin 30 % E.C. @ 1.5 kg ha^{-1} *fb* oxyfluorfen 23.5 % E.C. @ 100 g ha^{-1} at 20-30 DAS, except T_3:Two hand weeding (At 20 and 40 DAS). Whereas, significantly higher total weed density (34.33 m^{-2}), (48.67 m^{-2}), (57.33 m^{-2}) and (42.67 m^{-2}) was recorded in un-weeded check (Table 1).

The maximum and minimum density of weeds recorded with un-weeded check and weed free check. Pendimethalin 30 % E.C. @ 1.5 kg ha^{-1} *fb* one hand weeding at 25 DAS was comparable with pendimethalin 30 % E.C. @ 1.5 kg ha^{-1} *fb* quizalofop-p-ethyl 5 % E.C. @ 50 g ha^{-1} 20-30 DAS and pendimethalin 30 % E.C. @ 1.5 k ha^{-1} *fb* imazethapyr 10 % S.L.@ 75 g ha^{-1} at 20-30 DAS. Similar findings were reported earlier by Sumathi*et al.* (2000). This also might be due to pre-emergence application of pendimethalin which suppressed the early-emerged broad leaved weeds and post-emergence application of imazethapyr suppressed the late-emerged weeds. Similar findings were reported by Sasikala (2004) and Chaitanya *et al*. (2012). The reduced weed density in these treatments might also be due to initial suppression of weeds by pre emergence herbicide and at later stages by hand weeding or sequential application of herbicide. The results are corroborating with those reported by Rao (2000) and Chaitanya *et al*. (2012).

Influence of bio-efficacy of herbicides on weed dry matter

Total weed dry matter differed significantly due to different weed management treatments. The lowest total weed dry matter (36.00 g m^{-2}), (36.03 g m^{-2}), (37.57g m^{-2}) and (29.26g m^{-2}) at 20, 40, 60 DAS and at harvest recorded significantly lower weed dry matter with T_4*i.e.*, pre-emergence application of pendimethalin 30 % E.C. @ 1.5 kg ha^{-1} followed by one hand weeding at 25 DAS, followed T_7: pendimethalin 30 % E.C. @ 1.5 kgha^{-1} imazethapyr 10 % S.L. @ 75 g ha^{-1} at 20-30 DAS and T_9. Whereas, significantly higher total weed dry matter (68.73 g m^{-2}), (101.43g m^{-2}), (118.47 g m^{-2}) and (86.77 g m^{-2}) was recorded in un-weeded check. At 60 DAS and at harvest, dry weight of weeds was significantly reduced by all treatments over control. The maximum dry weight was recorded with weedy check and the minimum with the two hand weeding at 20 and 40 DAS. Treatment involving hand weeding at 20 and 40 DAS (T_3) was on par with pendimethalin followed by hand weeding at 25 DAS (T_4). Similar findings were reported by Chandolia*et al*. (2010).

Influence of bio-efficacy of herbicides on weed control efficiency

Weed control efficiency denotes the efficiency of applied herbicide or treatment effect in reducing the dry weight of weeds. It was computed with the dry matter of weeds at 20, 40, 60 DAS and at harvest. At 20 DAS, higher weed control efficiency (44.9 %) was recorded with pendimethalin 30 % E.C. @ 1.5 kg ha^{-1} *fb* one hand weeding at 25 DAS followed by T_6: pendimethalin 30 % E.C. @ 1.5 kg ha^{-1} *fb* quizalofop-p-ethyl 5 % E.C. @ 50 g ha^{-1} 20-30 DAS and T_7 :pendimethalin 30 % E.C. @ 1.5 kg ha^{-1} *fb* imazethapyr 10 % S.L. @ 75 g ha^{-1} at 20-30 DAS.This might be due to reduced density and dry weight of weeds to some extent with the pre-emergence application of pendimethalin. At 40 DAS, higher weed control efficiency (66.2 %) was recorded with pendimethalin 30 % E.C. @ 1.5 kg ha^{-1} *fb* one hand weeding at 25 DAS. This was on a par with the treatments where pendimethalin 30 % E.C. @ 1.5 kg ha^{-1} *fb* quizalofop-p-ethyl 5 % E.C. @ 50 g ha^{-1} 20-30 DAS and pendimethalin 30 % E.C. @ 1.5 kg ha^{-1} *fb* imazethapyr 10 % S.L. @ 75 g ha^{-1} at 20-30 DAS is involved. Similar results were reported by Sasikala *et al*. (2004) and Chaitanya *et al*. (2012) in groundnut.At 60 DAS, higher weed control efficiency (70.31 %) was recorded with the treatment where hand weeding was done at 20 and 40 DAS which was on par with), T_4: pendimethalin 30 % E.C. @ 1.5 kg ha^{-1} *fb* One hand weeding at 25DAS, T_5: oxyfluorfen 23.5 % E.C. @ 200 g ha^{-1} *fb* One hand weeding at 25 DAS, T_6: pendimethalin 30 % E.C. @ 1.5 kg ha^{-1} *fb* quizalofop-p-ethyl 5 % E.C. @ 50 gha^{-1} 20-30 DAS, T_7: pendimethalin 30 % E.C.

@ 1.5 kg ha^{-1} imazethapyr 10 % S.L. @ 75 gha^{-1} at 20-30 DAS and T_9: pendimethalin 30 % E.C. @ 1.0 kg ha^{-1} *fb* One hand weeding at 25 DAS. These results were akin to those reported by Chandrika (2004) and Chaitanya *et al.* (2012). Higher weed control efficiency in these treatments might be due to lower dry weight of weeds. At harvest, higher weed control efficiency was recorded with two hand weeding at 20 and 40 DAS (T_3). T_4: pendimethalin 30 % E.C. @ 1.5 kg ha^{-1} *fb* One hand weeding at 25 DAS, T_6: pendimethalin 30 % E.C. @ 1.5 kg ha^{-1} *fb* quizalofop-p-ethyl 5 % E.C. @ 50 g ha^{-1} 20-30 DAS and T_7: pendimethalin 30 % E.C. @ 1.5 kg ha^{-1} imazethapyr 10 % S.L. @ 75 g ha^{-1} at 20-30 DAS treatments were on a parwith T_1: Unweeded check.

Influence of bio-efficacy of herbicides on weed index

Weed index is the extent of yield reduction due to competition from weeds. All the weed management treatments recorded lower weed index than unweeded check. The data on weed index revealed that, among the herbicidal treatments, the lowest weed index (6.4 %) was recorded with the treatments where pre-emergence application of pendimethalin 30 % E.C. @ 1.5 kg ha^{-1} followed by one hand weeding at 25 DAS. This treatment was on par with T_6: pendimethalin 30 % E.C. @ 1.5 kg ha^{-1} *fb* quizalofop-p-ethyl 5 % E.C. @ 50 g ha^{-1} 20-30 DAS and T_7: pendimethalin 30 % E.C. @ 1.5 kg ha^{-1} imazethapyr 10 % S.L.@ 75 g ha^{-1} at 20-30 DAS.Similar findings were obtained by Rao *et al*. (2011). The highest weed index was recorded with unweeded check which might be due to higher dry matter accumulation of weeds because of season long weed competition which consequently, reduced crop yield.

Influence of bio-efficacy of herbicides on yield

A critical examination of the data revealed that the higher pod yield (2,255 kg ha^{-1}) and kernel yield (1,294 kg ha^{-1}) was recorded with the treatment where pendimethalin 30 % E.C. @ 1.5 kg ha^{-1} *fb*one hand weeding at 25 DAS (Table 4). Similar findings were reported by Sagvekar*et al*. 2015. The cumulative effect of the yield attributing characters was reflected in terms of pod yield. Unweeded check treatment recorded significantly lower pod yield (1453 kg ha^{-1}) and kernel yield (777 kg ha^{-1}) than all other treatments and it accounted for 35.6 per cent reduction when compared to pendimethalin 30 % E.C. @ 1.5 kg ha^{-1} *fb* one hand weeding at 25 DAS. This might be due to higher weed density and weed dry matter production in the unweeded check, which depleted the nutrients and moisture from soil, which were the most limiting factors for growth, yield attributing characters and yields of

crop. Further this treatment was at par with pendimethalin 30 % E.C. @ 1.5 kg ha^{-1} *fb* quizalofop-p-ethyl 5 % E.C. @ 50 g ha^{-1} 20-30 DAS and pendimethalin 30 % E.C. @ 1.5 k ha^{-1} *fb*imazethapyr 10 % S.L. @ 75 g ha^{-1} at 20-30 DAS. Reduction in weed competition, improves growth parameters and these improved growth parameters increases the yield attributes which in turn increase pod yield. These results are in conformity with Sasikala *et al.* (2006) and Chaitanya *et al.* (2013).

Influence of bio-efficacy of herbicides on quality parameters

The results revealed that, significantly higher oil and protein content (47.28 and 26.54 %, respectively) was observed in weed free check (Table 5) as compared to other weed management treatments. The among the weed management practices, higher oil content (47.26%) and protein content (26.51%) was noticed in Pendimethalin 30 % E.C. @1.5 kg ha^{-1} (PE) *fb*One hand weeding at 25 DAS (T_4) as compared to un-weeded check (44.02% in oil content) and 24.59 % in protein content.These results are in conformity with kumara *et al.* (2020).

CONCLUSION

Thus, it can concluded that, pre-emergence application of pendimethalin 30 % E.C. @ 1.5 kg ha^{-1} followed by one hand weeding at 25 DAS observed lowered total weed density, weed dry matter, higher weed control efficiency with lower weed index and further higher pod yield, kernel yield and quality of groundnutunder rice-groundnut system in coastal zone of Karnataka

Table 1: Total weed density of groundnut as influenced by weed management treatments at different growth stages

Treatments		Total weed density (No. m^{-2})			
		20 DAS	**40 DAS**	**60 DAS**	**At harvest**
T_1	Un-weeded check	12.95 (34.33)	14.93 (48.67)	16.01 (57.33)	13.96 (42.67)
T_2	Weed free check	3.00 (0.00)	3.00 (0.00)	3.00 (0.00)	3.00 (0.00)
T_3	Two hand weeding (At 20 and 40 DAS)	12.97 (29.33)	12.24 (29.00)	9.83 (17.00)	8.94 (12.33)
T_4	Pendimethalin 30 % E.C. @1.5 kg ha^{-1} (PE) *fb* One hand weeding at 25 DAS (POE)	10.28 (18.33)	9.80 (15.67)	10.17 (19.33)	9.38 (14.33)
T_5	Oxyfluorfen 23.5% E.C. @ 200 g ha^{-1} (PE) *fb* One hand weeding at 25 DAS	11.01 (22.00)	10.20 (16.66)	10.30 (18.00)	10.14 (17.33)
T_6	Pendimethalin 30 % E.C. @1.5 kg ha^{-1} (PE) *fb*Quizalofop-p-ethyl 5% E.C. @ 50 g ha^{-1} 20- 30 DAS (POE)	10.66 (20.33)	10.55 (19.33)	10.46 (18.67)	10.01 (17.67)
T_7	Pendimethalin 30% E.C. @1.5 kg ha^{-1} (PE) *fb* Imazethapyr 10 % S.L. @ 75 g ha^{-1} at 20- 30 DAS (POE)	10.74 (20.37)	10.48 (19.67)	10.33 (18.33)	9.58 (15.00)
T_8	Pendimethalin 30% E.C. @1.5 kg ha^{-1} (PE) *fb* Oxyfluorfen 23.5% E.C. @ 100 g ha^{-1} at 20-30 DAS (POE)	10.82 (21.00)	10.70 (20.33)	11.01 (22.00)	10.27 (18.00)
T_9	Pendimethalin 30% E.C. @1.0 kg ha^{-1} (PE) *fb* One hand weeding at 25 DAS.	11.77 (26.00)	9.76 (16.33)	10.84 (20.67)	9.66 (15.33)
	S.Em.±	0.34	0.51	0.28	0.23
	C.D. at 5%	1.03	1.54	0.84	0.70

Table 2: Total weed dry matter of groundnut as influenced by weed management treatments at different growth stages

Treatments		Total weed dry matter (g m-2)			
		20 DAS	**40 DAS**	**60 DAS**	**At harvest**
T_1	Un-weeded check	16.89 (68.73)	20.22 (101.43)	21.70 (118.47)	18.62 (86.77)
T_2	Weed free check	3.00 (0.00)	3.00 (0.00)	3.00 (0.00)	3.00 (0.00)
T_3	Two hand weeding (At 20 and 40 DAS)	16.10 (60.73)	16.62 (62.63)	13.24 (36.90)	11.89 (27.07)
T_4	Pendimethalin 30 % E.C. @1.5 kg ha^{-1} (PE) *fb* One hand weeding at 25 DAS (POE)	13.17 (36.00)	13.35 (36.03)	13.55 (37.57)	12.24 (29.26)
T_5	Oxyfluorfen 23.5% E.C. @ 200 g ha^{-1} (PE) *fb* One hand weeding at 25 DAS	13.86 (40.43)	14.01 (40.63)	14.62 (45.20)	13.10 (34.93)
T_6	Pendimethalin 30 % E.C. @1.5 kg ha^{-1} (PE) *fb*Quizalofop-p-ethyl 5% E.C. @ 50 g ha^{-1} 20- 30 DAS (POE)	13.66 (40.20)	15.10 (43.80)	14.59 (45.40)	13.41 (37.31)
T_7	Pendimethalin 30% E.C. @1.5 kg ha^{-1} (PE) *fb* Imazethapyr 10 % S.L. @ 75 g ha^{-1} at 20- 30 DAS (POE)	13.81 (41.20)	14.39 (45.30)	14.54 (45.00)	12.74 (32.47)
T_8	Pendimethalin 30% E.C. @1.5 kg ha^{-1} (PE) *fb* Oxyfluorfen 23.5% E.C. @ 100 g ha^{-1} at 20-30 DAS (POE)	13.95 (41.13)	14.43 (44.83)	14.70 (46.00)	13.38 (36.80)
T_9	Pendimethalin 30% E.C. @1.0 kg ha^{-1} (PE) *fb* One hand weeding at 25 DAS.	14.80 (48.67)	13.85 (39.40)	13.93 (40.00)	12.74 (32.23)
	S.Em.±	0.49	0.66	0.31	0.22
	C.D. at 5%	1.46	1.97	0.94	0.65

Table 3: Weed check efficiency and weed index of groundnut as influenced by weed management treatments at different stages

Treatments		Weed control efficiency (%)				Weed index (%)
		20 DAS	40 DAS	60 DAS	At harvest	
T_1	Un-weeded check	0.0	0.0	0.0	0.0	39.2
T_2	Weed free check	100.0	100.0	100.0	100.0	0.0
T_3	Two hand weeding (At 20 and 40 DAS)	20.7	38.6	70.3	71.1	17.6
T_4	Pendimethalin 30 % E.C. @1.5 kg ha^{-1} (PE) *fb* One hand weeding at 25 DAS (POE)	44.9	66.2	66.3	66.2	6.4
T_5	Oxyfluorfen 23.5% E.C. @ 200 g ha^{-1} (PE) *fb* One hand weeding at 25 DAS	34.2	63.6	68.4	59.3	31.9
T_6	Pendimethalin 30 % E.C. @1.5 kg ha^{-1} (PE) *fb*Quizalofop-p-ethyl 5% E.C. @ 50 g ha^{-1} 20- 30 DAS (POE)	39.4	58.9	67.4	59.2	11.0
T_7	Pendimethalin 30% E.C. @1.5 kg ha^{-1} (PE) *fb* Imazethapyr 10 % S.L. @ 75 g ha^{-1} at 20- 30 DAS (POE)	38.4	58.1	68.0	64.8	11.4
T_8	Pendimethalin 30% E.C. @1.5 kg ha^{-1} (PE) *fb* Oxyfluorfen 23.5% E.C. @ 100 g ha^{-1} at 20-30 DAS (POE)	36.4	57.4	61.5	57.2	29.4
T_9	Pendimethalin 30% E.C. @1.0 kg ha^{-1} (PE) *fb* One hand weeding at 25 DAS.	21.4	66.6	64.0	63.8	15.9
	S.Em.±	5.8	5.3	2.5	3.1	3.6
	C.D. at 5%	17.5	16.0	7.5	9.2	10.8

Table 4: Pod yield, kernel yield and harvest index of groundnut as influenced by weed management treatments

Treatments		Pod yield (kg ha^{-1})	Kernel yield (kg ha^{-1})	Harvest index
T_1	Un-weeded check	1,453	777	0.25
T_2	Weed free check	2,408	1,412	0.29
T_3	Two hand weeding (At 20 and 40 DAS)	1,974	1,080	0.27
T_4	Pendimethalin 30 % E.C. @1.5 kg ha^{-1} (PE) *fb* One hand weeding at 25 DAS (POE)	2,255	1,294	0.29
T_5	Oxyfluorfen 23.5% E.C. @ 200 g ha^{-1} (PE) *fb* One hand weeding at 25 DAS	1,633	881	0.27
T_6	Pendimethalin 30 % E.C. @1.5 kg ha^{-1} (PE) *fb*Quizalofop-p-ethyl 5% E.C. @ 50 g ha^{-1} 20- 30 DAS (POE)	2,145	1,201	0.27
T_7	Pendimethalin 30% E.C. @1.5 kg ha^{-1} (PE) *fb* Imazethapyr 10 % S.L. @ 75 g ha^{-1} at 20-30 DAS (POE)	2,133	1,181	0.28
T_8	Pendimethalin 30% E.C. @1.5 kg ha^{-1} (PE) *fb* Oxyfluorfen 23.5% E.C. @ 100 g ha^{-1} at 20-30 DAS (POE)	1,688	907	0.28
T_9	Pendimethalin 30% E.C. @1.0 kg ha^{-1} (PE) *fb* One hand weeding at 25 DAS.	2,023	1,092	0.27
	S.Em.±	98	39	0.01
	C.D. at 5%	293	119	0.02

Table 5: Quality parameters of groundnut as influenced by weed management treatments

Treatments		Oil content (%)	Crude Protein content (%)	Carbohydrate (%)
T_1	Un-weeded check	44.02	24.89	9.21
T_2	Weed free check	47.28	26.54	9.58
T_3	Two hand weeding (At 20 and 40 DAS)	45.89	25.45	9.35
T_4	Pendimethalin 30 % E.C. @1.5 kg ha^{-1} (PE) *fb* One hand weeding at 25 DAS (POE)	47.26	26.51	9.57
T_5	Oxyfluorfen 23.5% E.C. @ 200 g ha^{-1} (PE) *fb* One hand weeding at 25 DAS	45.12	25.03	9.28
T_6	Pendimethalin 30 % E.C. @1.5 kg ha^{-1} (PE) *fb*Quizalofop-p-ethyl 5% E.C. @ 50 g ha^{-1} 20- 30 DAS (POE)	46.58	26.14	9.50
T_7	Pendimethalin 30% E.C. @1.5 kg ha^{-1} (PE) *fb* Imazethapyr 10 % S.L. @ 75 g ha^{-1} at 20- 30 DAS (POE)	46.25	26.02	9.45
T_8	Pendimethalin 30% E.C. @1.5 kg ha^{-1} (PE) *fb* Oxyfluorfen 23.5% E.C. @ 100 g ha^{-1} at 20-30 DAS (POE)	45.21	25.12	9.28
T_9	Pendimethalin 30% E.C. @1.0 kg ha^{-1} (PE) *fb* One hand weeding at 25 DAS.	46.98	26.14	9.48
	S.Em.±	0.12	0.15	0.25
	C.D. at 5%	0.40	0.49	NS

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