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Impact of integrated weed management practices on weed parameters and yield of pearl millet [*Pennisetum glaucum* L. Br. Emend. Stuntz.]

Charul Chaudhary, VS Hooda, Isha, Mehak Nagora, Shital Kumar and DP Nandal

Abstract
A field experiment was conducted at Agronomy research farm of CCS Haryana Agricultural University, Hisar, Haryana during *Kharif* 2017. Three pre-emergence herbicides *viz.*, atrazine at 500 g ha-1, atrazine at 750 g ha-1 and pendimethalin at 1000 g ha-1, one pre-emergence herbicides mixture *viz.*, atrazine + pendimethalin at (0.4+0.75 kg/ha), four post-emergence herbicides at 2-4 leaf stage/ 10-15 DAS *viz.*, atrazine at 0.5 kg/ha application, atrazine at 0.75 kg/ha, tembotrione (Laudis) at 80g/ha and tembotrione (Laudis) at 100g/ha, two pre-emergence herbicides with one hand weeding at 21 DAS *viz.*, atrazine at 0.4 kg/ha and pendimethalin at 0.75 kg/ha, one pre-emergence herbicides mixture with one hand weeding at 21 DAS *viz.*, atrazine + pendimethalin at (0.4+0.75 kg/ha), three post-emergence herbicides with one hand weeding at 30 DAS *viz.*, atrazine at 0.4 kg/ha (POST) at 10-14 DAS, tembotrione (Laudis) at 80g/ha (POST) at 2-4 leaf/10-15 DAS and tembotrione (Laudis) at 100g/ha (POST) at 2-4 leaf/10-15 DAS and two hand weedings at 15 and 30 DAS were compared with weed free and weedy check. Seventeen treatments were tested using a randomised block design with three replications. Observations on growth studies, yield attributes, yield, weed studies, seed parameters and economics of pearl millet were recorded. Predominant weed species observed in the experimental plots were *Cyperus rotundus, Echinochloa colona, Trianthema portulacastrum* and *Digera arvensis.* Application of Tembotrione (Laudis) @80g/ha (PoE) at 2-4 leaf/10-15 DAS + one HW at 30 DAS (T15) and Tembotrione (Laudis) @100g/ha (PoE) at 2-4 leaf/10-15 DAS + one HW at 30 DAS (T16) recorded significantly lower weed population, dry weight of weeds and higher weed control efficiency at all growth stages with good crop growth. In weed control method, effective control of weeds, higher grain and stover yield, net income and B: C were obtained with application of Tembotrione (Laudis) @80g/ha (PoE) at 2-4 leaf/10-15 DAS + one HW at 30 DAS.

Keywords: Integrated, management, practices, parameters, *Pennisetum glaucum* L.

Introduction
Pearl millet [*Pennisetum glaucum* (L.) R. Br. emend. Stuntz] is the sixth most important cereal in the world and stands fourth, in order of importance as a food grain in India. It is commonly called as *Bajra*, Indian millet, Bulrush millet, Cattail millet and Pencillaria. Being short in duration, it is the most drought-tolerant cereal grown in the arid and semi-arid areas of the world (Bhagavatula *et al.*, 2013) [5]. This crop is native of Africa and it is an important crop of the semi-arid and arid areas of India, where soils are loamy sand with low fertility, poor microbial activity, low organic matter content, high infiltration rate, poor moisture storage capacity and precarious rainfall (150-400 mm). It uses up a choice place in dryland agriculture economy of the world. Pearl millet is having a drought-escaping mechanism but still responds well to irrigation and improved agronomic management practices. Because of its adaptability to drier and low fertility conditions, it has a relative advantage over other cereal crops under such conditions; therefore, it is an important part of food security in the state. Today, it is taking more attention due to increasing evidence of less seasonal rainfall, terminal heat, the frequent occurrence of extreme weather events coupled with scanty water resources. It fills a distinct place in the agrarian economy of the country (Ansari *et al.*, 2012) [3]. Pearl millet produces grain and fodder under very hot and dry weather and on soils too poor for sorghum and maize. Due to a combination of rapid growth rate when conditions are favorable, high-temperature tolerance and ability to extract mineral nutrition and water from even the poorest soils make it unacceptable to circumvent in the world's hardest agricultural production environment.

It is largely a rain-fed crop, except when it rises as a summer irrigated crop. Overall, just 10% of the pearl millet area is irrigated in India. During the last six decades, the consumption preferences of human beings turned from health and nutrition towards taste and convenience. In terms of area under pearl millet, Rajasthan stands out as the number one state, with a share of nearly 57% in the country's area during 2011-15 (quinquennial average). Uttar Pradesh comes a distant second with a share of around 11.2%. Maharashtra, Gujarat, and Haryana occupy the following three positions with shares of 10, 8.5 and 6%, respectively. These five states together had a share of 93% in the total area. Haryana had a share of 9.6% in production because of a high productivity of 1,908 kg/ha.

Besides various constraints regarding pearl millet productivity, severe infestation of weeds during rainy season sub-optimizes the production of pearl millet.

Weed management in pearl millet during the early growth period of the crop is quite significant. Like other rainy season crops, pearl millet faces severe weed competition resulting in heavy reduction in grain production. On an average, 55% yield reduction in pearl millet due to weed infestation was observed by Banga *et al*. (2000) [4]. Das and Yaduraju (1995) [6] have reported 72% or more yield loss in pearl millet due to initial slow growth. Many studies at indicated yield losses up to 31.3 to 45.9% from Delhi (Panwar *et al.*, 1991) [10]. It picks up growth, starts tillering and increase in height after 25-30 DAS and becomes more competitive against weeds. The field should be kept free from weeds at least for the initial 25-30 DAS. The predominant methods of weed management in pearl millet crop are inter-culturing and hand weeding. Manual weeding is the conventional method of weed control in pearl millet and it is expensive and time-consuming. Now-a-days, use of herbicides have revolutionized weed management and brings down the cost of cultivation. But the side benefits of mechanical measures *viz.* loosening of soil, root aeration and penetration, moisture conservation etc. cannot be ignored. Lately, labour scarcity during the rainy season has accentuated the usage of herbicides indispensable for timely weed control. Manual weeding or spraying of recommended pre-emergence herbicides becomes sometimes difficult in the rainy season for effective weed control, thus, it necessitates the use post-emergenceherbicides.

Consequently, integrated approaches for weed management using chemical and manual methods were evaluated for effective weed management. The present experiment was undertaken in pearl millet to find out an efficient combination of weed control methods to increase productivity in pearl millet.

Materials and Methods

To evaluate the effect of various weed control treatments on growth parameters, yield attributes and yield of crop. The experiment was conducted at Research farm, Department of Agronomy, CCS Haryana Agricultural University, Hisar, India during *Kharif* 2017. Treatments in the study were three pre-emergence herbicides *viz.*, atrazine at 500 g ha-1, atrazine at 750 g ha-1 and pendimethalin at 1000 g ha-1, one pre-emergence herbicides mixture *viz.*, atrazine + pendimethalin at (0.4+0.75 kg/ha), four post-emergence herbicides at 2-4 leaf stage/ 10-15 DAS *viz.*, atrazine at 0.5 kg/ha application, atrazine at 0.75 kg/ha, tembotrione (Laudis) at 80g/ha and tembotrione (Laudis) at 100g/ha, two pre-emergence herbicides with one hand weeding at 21 DAS *viz.*, atrazine at 0.4 kg/ha and pendimethalin at 0.75 kg/ha, one pre-emergence herbicides mixture with one hand weeding at 21 DAS *viz.*, atrazine + pendimethalin at (0.4+0.75 kg/ha), three post-emergence herbicides with one hand weeding at 30 DAS *viz.*, atrazine at 0.4 kg/ha (POST) at 10-14 DAS, tembotrione (Laudis) at 80g/ha (POST) at 2-4 leaf/10-15 DAS and tembotrione (Laudis) at 100g/ha (POST) at 2-4 leaf/10-15 DAS and two hand weedings at 15 and 30 DAS were compared, with weed free and weedy check. Seventeen treatments were tested using a randomised block design with three replications. The soil of the field was sandy loam in texture, medium in organic carbon (0.52%), medium in phosphorus (18 kg P2O5 ha-1) and potassium (285 kg K2Oha-1). Each plot size was 12m×2.5m. The pearl millet variety HHB-223 was sown on 25thJuly 2017 during *kharif* 2017. The seeding rate was 5 kg ha-1 at 45 cm row spacing. The pre-emergent herbicide pendimethalin and atrazine was applied immediately after sowing in moist soil, and post-emergent herbicides *i.e.*, atrazine, pendimethalin and tembotrione were applied 12 DAS with a knapsack sprayer fitted with a flat fan nozzle using a spray volume of 625 L ha-1. The hand weeding with pre- emergence herbicides was done at 21 DAS and hand weeding with post-emergent herbicides was done at 30 DAS. The crop was managed according to the standard agronomic practices of the state university. The experiment was conducted during *kharif* season of 2017. The data collected during the study were statistically analyzed by the method described by Panse and Sukhatme (1961). All the test of significance was made at the 5% level of significance. Experimental data of different parameters were analyzed in one-factor-randomized block design with three replications by using OPSTAT statistical software (http://14.139.232.166/op stat/index.- asp) developed by Chaudhary Charan Singh Haryana Agricultural University.

Result and discussion

Results showed that all the weed management treatments significantly reduced the density and dry matter of weeds at all the stages of observation in comparison to weedy check that was found to be the most severely infested with weeds.

Among pre-emergence herbicide treatments the lowest weed density, total weed dry wt., weed control efficiency, visual control and highest yield was obtained in atrazine

0.75 kg/ha PRE (T4) at 20, 40, 60 DAS and at harvest. But pre-emergence herbicides with one hand weeding gave better result than sole pre-emergence herbicides, atrazine 0.4 kg/ha PRE + 1HW at 21 DAS (T5) obtained better results. The superiority of these treatments could mainly be ascribed to the fact that application of herbicide alone inhibited the germination and emergence of weeds during initial growth stage of crop only but at later stages, these herbicides dissipated and deactivated in the soil and second

flush of weeds appeared in such plots. The hand weeding done at 20 DAS effectively controlled the weeds that emerged at later stage and thus kept the field weed free for a longer duration. Accelerated growth of crop due to looseness of soil and aeration in root zone incurred due to hoeing could be assigned as another reason of lower density and dry matter of weeds obtained under these treatments. Overall, among herbicidal treatments tembotrione 100 g/ha PoE at 2-4 leaf/10-15 DAS + 1 HW at 30 DAS (T16) recorded lower weed density and dry weight and higher weed control efficiency of *Cyperus rotundus, Echinochloa colona, Trianthema portulacastrum* and *Digera arvensis*, remaining at par with two HW/hoeing at 15 and 30 DAS (T17) at all the stages and with tembotrione 80g/ha PoE at 2-4 leaf/10-15 DAS + 1 HW at 30 DAS at 40, 60 DAS and at harvest. The maximum weed control efficiency and visual control of 100% at all stages was recorded under weed free treatment. In herbicidal treatments more effective treatment was tembotrione 100g/ha PoE at 2-4 leaf/10-15 DAS + 1 HW at 30 DAS (T16) at 20 and 40 DAS which was followed by two HW/hoeing at 15 and 30 DAS. At 60 DAS and at harvest, tembotrione 80g/ha PoE at 2-4 leaf/10-15 DAS + 1 HW at 30 DAS (T15) gives higher weed control efficiency followed by tembotrione 100g/ha PoE at 2-4 leaf/10- 15 DAS + 1 HW at 30 DAS (T16). Inhibition of germination of weeds and their growth following application of different herbicides might have reduced the growth of weeds through arresting cell division and elongation and thus causing mortality of weeds. These seem to be the most spectacular reasons of accumulating lesser dry weight of weeds and as a consequently the higher weed control efficiencies.

Reduction in crop-weed competition under these treatments saved a substantial amount of nutrients for crop which led to accelerated growth enabling the crop to utilize more soil moisture and nutrients. All these favorable effects resulted significant increase in various yield determining characters of pearl millet *viz.*, number of grains/ear, length of ear and test weight by improving source-sink relationship. The higher values of yield attributes coupled with higher dry matter recorded under these treatments might be the most probable reason of higher grain yield. In the presence of weeds, although vegetative growth occurred but sink was not sufficient enough to accumulate the meaningful food assimilates translocating towards grain formation. The higher grain yield and stover yield was obtained under weed free treatment while the lowest observed under weedy check. Among pre-emergence herbicide treatments the higher grain yield and stover yield was obtained in atrazine + pendimethalin (0.4+0.75 kg/ha) PRE (T11) which was at par with atrazine 0.5 kg/ha PRE (T3), atrazine 0.75 kg/ha PRE (T4) and pendimethalin 1.0 kg/ha PRE (T9). But the pre-emergence herbicides with one hand weeding obtained higher yield and stover yield in comparison of sole treatment of pre-emergence herbicides. Atrazine + pendimethalin (0.4+0.75 kg/ha) PRE + 1 HW at 21 DAS (T12) observed higher yield which was at par with atrazine 0.4 kg/ha PRE + 1 HW at 21 DAS (T5) and pendimethalin 0.75 kg/ha PRE + 1HW at 21 DAS (T10). In post emergence herbicide treatments the higher grain yield and stover yield was obtained in atrazine 0.4 kg/ha PoE (10-14 DAS) + 1 HW at 30 DAS (T8) which was at par with tembotrione 100g/ha PoE at 2-4 leaf/10-15 DAS (T14). But post emergence herbicides with one hand weeding performed better than sole post emergence herbicide treatments. Tembotrione 80g/ha PoE at 2-4 leaf/10-15 DAS + 1 HW at 30 DAS (T15) recorded higher grain yield, being at par with tembotrione 100g/ha PoE at 2-4 leaf/10-15 DAS + 1 HW at 30 DAS (T16). Overall maximum grain yield and stover yield was observed in tembotrione 80g/ha PoE at 2-4 leaf/10-15 DAS + 1 HW at 30 DAS (T15) being at par with tembotrione 100g/ha PoE at 2-4 leaf/10-15 DAS + 1 HW at 30 DAS (T16).

Table 1: Effect of various weed control treatments on C. rotundus and E. colona density in pearl millet

Treatment		***C. rotundus* density (No./m2)**				***E. colona* density (No./m2)**			
		20 DAS	**40 DAS**	**60 DAS**	**At Harvest**	**20 DAS**	**40 DAS**	**60 DAS**	**At Harvest**
T1:	Weedy check	5.53 (29.58)	6.03 (35.41)	6.73 (44.25)	5.00 (24.00)	4.29 (17.41)	5.70 (31.50)	6.14 (36.75)	4.40 (18.33)
T2:	Weed free	1.00 (0)	1.00 (0)	1.00 (0)	1.00 (0)	1.00 (0)	1.00 (0)	1.00 (0)	1.00 (0)
T3:	Atrazine 0.5 kg/ha PRE	3.04 (8.23)	4.10 (15.78)	4.63 (20.42)	4.20 (16.66)	2.66 (6.09)	3.90 (14.24)	4.23 (16.92)	3.65 (12.32)
T4:	Atrazine 0.75 kg/ha PRE	3.00 (8.00)	3.75 (13.08)	4.39 (18.25)	3.87 (14.00)	2.60 (5.75)	3.89 (14.16)	4.21 (16.75)	3.69 (12.66)
T5:	Atrazine 0.4 kg/ha PRE + 1HW at 21 DAS	3.19 (9.16)	2.71 (6.69)	3.92 (14.33)	3.44 (10.84)	2.78 (6.75)	2.86 (7.16)	4.17 (16.41)	3.38 (10.42)
T6:	Atrazine 0.5 kg/ha PoE (10-14 DAS)	3.00 (9.87)	4.52 (19.43)	4.95 (23.51)	4.43 (18.62)	2.67 (6.14)	4.11 (15.89)	4.39 (18.24)	3.82 (13.62)
T7:	Atrazine 0.75 kg/ha PoE (10-14 DAS)	2.92 (7.45)	4.32 (17.65)	4.74 (21.41)	4.33 (17.79)	2.63 (5.92)	4.08 (15.67)	4.28 (17.35)	3.81 (13.48)
T8:	Atrazine 0.4 kg/ha PoE (10-14 DAS) + 1 HW at 30 DAS	3.38 (10.46)	3.12 (8.73)	4.01 (15.07)	3.50 (11.28)	2.66 (6.08)	2.89 (7.35)	4.24 (17.01)	3.52 (11.43)
T9:	Pendimethalin 1.0 kg/ha PRE	3.25 (9.58)	3.94 (14.50)	4.36 (18.00)	4.09 (15.73)	2.83 (7.00)	3.72 (12.83)	4.19 (16.58)	3.44 (10.83)
T10:	Pendimethalin 0.75 kg/ha PRE + 1HW at 21 DAS	3.33 (10.06)	3.20 (9.23)	3.72 (12.85)	3.27 (9.66)	2.87 (7.23)	2.84 (7.08)	4.23 (16.92)	3.38 (10.45)
T11:	Atrazine + pendimethalin (0.4+0.75 kg/ha) PRE	3.06 (8.34)	3.52 (11.42)	4.19 (16.59)	3.59 (11.85)	2.70 (6.31)	3.50 (11.24)	4.34 (17.86)	3.53 (11.48)
T12	: Atrazine + pendimethalin (0.4+0.75 kg/ha) PRE + 1HW at 21 DAS	3.03 (8.18)	2.77 (6.66)	4.01 (15.08)	3.52 (11.42)	2.86 (7.17)	2.99 (7.91)	4.22 (16.83)	3.36 (10.26)
T13:	Tembotrione 80g/ha PoE at 2-4 leaf/10-15 DAS	2.90 (7.39)	3.76 (13.15)	4.31 (17.57)	3.98 (14.82)	2.34 (4.48)	3.86 (13.89)	4.28 (17.35)	3.62 (12.13)
T14:	Tembotrione 100g/ha PoE at 2-4 leaf/10-15 DAS	2.74 (6.50)	3.68 (12.58)	4.12 (16.00)	3.82 (13.58)	2.29 (4.26)	3.70 (12.66)	4.20 (16.66)	3.41 (10.66)
T15:	Tembotrione 80g/ha PoE at 2-4 leaf/10-15 DAS + 1 HW at 30 DAS	2.87 (7.23)	2.82 (6.95)	3.37 (10.34)	2.73 (6.43)	2.27 (4.15)	2.53 (5.42)	3.95 (14.61)	3.08 (8.46)
T16:	Tembotrione 100g/ha PoE at 2-4 leaf/10-15 DAS + 1 HW at 30 DAS	2.73 (6.48)	2.78 (6.73)	3.54 (11.56)	2.82 (6.98)	2.31 (4.35)	2.67 (6.13)	4.09 (15.71)	3.17 (9.08)
T17:	Two HW/hoeing at 15 and 30 DAS CD at 5%	2.76 (6.59)	3.03 (8.21)	3.71 (12.77)	3.09 (8.56)	2.41 (4.82)	2.80 (6.85)	4.16 (16.29)	3.32 (10.01)
		0.15	0.17	0.21	0.18	0.12	0.17	0.21	0.17

Table 2: Effect of various weed control treatments on D. arvensis and T. portucalastrum density in pearl millet

	Treatment	*D. arvensis* density (No./m2)				*T. portucalastrum* density (No./m2)			
		20 DAS	40 DAS	60 DAS	At Harvest	20 DAS	40 DAS	60 DAS	At Harvest
T1:	Weedy check	2.69 (6.25)	3.20 (9.25)	3.97 (14.75)	2.80 (6.83)	4.59 (20.08)	5.15 (25.58)	5.44 (28.58)	4.13 (16.08)
T2:	Weed free	1.00 (0)	1.00 (0)	1.00 (0)	1.00 (0)	1.00 (0)	1.00 (0)	1.00 (0)	1.00 (0)
T3:	Atrazine 0.5 kg/ha PRE	1.68 (1.82)	2.32 (4.37)	2.62 (5.84)	2.22 (3.92)	2.87 (7.24)	3.95 (14.47)	4.28 (17.32)	3.29 (9.84)
T4:	Atrazine 0.75 kg/ha PRE	1.58 (1.50)	2.16 (3.66)	2.46 (5.08)	2.10 (3.41)	2.79 (6.80)	3.85 (13.83)	4.26 (17.16)	3.21 (9.33)
T5:	Atrazine 0.4 kg/ha PRE + 1HW at 21 DAS	1.71 (1.91)	1.83 (2.33)	2.54 (5.45)	1.89 (2.58)	3.04 (8.25)	2.90 (7.41)	4.17 (16.41)	3.11 (8.66)
T6:	Atrazine 0.5 kg/ha PoE (10-14 DAS)	1.50 (1.24)	2.29 (4.26)	2.82 (6.93)	2.33 (4.42)	2.92 (7.52)	4.08 (15.67)	4.47 (18.95)	3.50 (11.24)
T7:	Atrazine 0.75 kg/ha PoE (10-14 DAS)	1.52 (1.32)	2.27 (4.15)	2.80 (6.82)	2.31 (4.35)	2.83 (6.99)	4.04 (15.34)	4.50 (19.22)	3.48 (11.12)
T8:	Atrazine 0.4 kg/ha PoE (10-14 DAS) + 1 HW at 30 DAS	1.49 (1.23)	1.90 (2.60)	2.52 (5.35)	2.05 (3.22)	2.97 (7.81)	3.25 (9.58)	4.10 (15.82)	3.29 (9.82)
T9:	Pendimethalin 1.0 kg/ha PRE	2.31 (4.33)	3.00 (8.00)	3.61 (12.00)	2.61 (5.83)	3.11 (8.66)	3.80 (13.41)	4.22 (16.83)	3.18 (9.08)
T10:	Pendimethalin 0.75 kg/ha PRE + 1HW at 21 DAS	2.35 (4.52)	2.50 (5.25)	3.34 (10.13)	2.33 (4.41)	3.05 (8.32)	2.94 (7.65)	4.05 (15.42)	3.05 (8.32)
T11:	Atrazine + pendimethalin (0.4+0.75 kg/ha) PRE	1.73 (1.99)	2.24 (4.01)	2.67 (6.12)	2.06 (3.24)	3.02 (8.12)	3.67 (12.45)	4.14 (16.15)	3.24 (9.52)
T12:	Atrazine + pendimethalin (0.4+0.75 kg/ha) PRE + 1HW at 21 DAS	1.72 (1.95)	1.94 (2.75)	2.58 (5.64)	1.95 (2.82)	3.02 (8.09)	2.99 (7.94)	4.13 (16.02)	3.12 (8.73)
T13:	Tembotrione 80g/ha PoE at 2-4 leaf/10-15 DAS	1.48 (1.20)	2.60 (5.78)	2.83 (6.99)	2.20 (3.84)	2.71 (6.35)	3.91 (14.29)	4.23 (16.92)	3.29 (9.82)
T14:	Tembotrione 100g/ha PoE at 2-4 leaf/10-15 DAS	1.44 (1.07)	2.45 (5.00)	2.78 (6.75)	2.14 (3.58)	2.52 (5.33)	3.75 (13.08)	4.21 (16.70)	3.18 (9.08)
T15:	Tembotrione 80g/ha PoE at 2-4 leaf/10-15 DAS + 1 HW at 30 DAS	1.48 (1.19)	1.93 (2.73)	2.47 (5.12)	1.88 (2.53)	2.77 (6.68)	2.68 (6.21)	3.80 (13.42)	2.69 (6.24)
T16:	Tembotrione 100g/ha PoE at 2-4 leaf/10-15 DAS + 1 HW at 30 DAS	1.43 (1.03)	1.87 (2.50)	2.50 (5.24)	1.96 (2.84)	2.48 (5.14)	2.73 (6.47)	3.82 (13.58)	2.65 (6.01)
T17:	Two HW/hoeing at 15 and 30 DAS	1.67 (1.79)	1.96 (2.84)	2.56 (5.57)	2.06 (3.24)	2.69 (6.26)	2.69 (6.24)	3.85 (13.82)	2.69 (6.23)
	CD at 5%	0.06	0.09	0.12	0.09	0.13	0.17	0.20	0.15

Table 3: Effect of various weed control treatments on *C. rotundus* and *E. colona* dry weight in pearl millet

	Treatment	Dry weight of *C. rotundus* (g/m2)				Dry weight of *E. colona* (g/m2)			
		20 DAS	40 DAS	60 DAS	At Harvest	20 DAS	40 DAS	60 DAS	At Harvest
T1:	Weedy check	2.19 (3.79)	5.17 (25.70)	7.26 (51.73)	5.67 (31.19)	3.38 (10.42)	5.15 (25.58)	5.44 (28.58)	4.13 (16.08)
T2:	Weed free	1.00 (0)	1.00 (0)	1.00 (0)	1.00 (0)	1.00 (0)	1.00 (0)	1.00 (0)	1.00 (0)
T3:	Atrazine 0.5 kg/ha PRE	1.47 (1.15)	3.95 (14.63)	5.22 (26.22)	4.50 (19.29)	2.22 (3.91)	3.95 (14.47)	4.28 (17.32)	3.29 (9.84)
T4:	Atrazine 0.75 kg/ha PRE	1.49 (1.23)	3.67 (12.45)	5.00 (24.05)	4.26 (17.17)	1.84 (2.40)	3.85 (13.83)	4.26 (17.16)	3.21 (9.33)
T5:	Atrazine 0.4 kg/ha PRE + 1HW at 21 DAS	1.46 (1.13)	2.02 (3.07)	4.19 (16.52)	3.88 (14.05)	2.24 (4.03)	2.90 (7.41)	4.17 (16.41)	3.11 (8.66)
T6:	Atrazine 0.5 kg/ha PoE (10-14 DAS)	1.56 (1.42)	4.27 (17.25)	5.18 (25.88)	4.76 (21.62)	2.29 (4.23)	4.08 (15.67)	4.47 (18.95)	3.50 (11.24)
T7:	Atrazine 0.75 kg/ha PoE (10-14 DAS)	1.55 (1.39)	4.17 (16.42)	5.06 (24.63)	4.64 (20.54)	2.24 (4.02)	4.04 (15.34)	4.50 (19.22)	3.48 (11.12)
T8:	Atrazine 0.4 kg/ha PoE (10-14 DAS) + 1 HW at 30 DAS	1.48 (1.20)	2.06 (3.24)	4.41 (18.44)	4.02 (15.18)	2.14 (3.56)	3.25 (9.58)	4.10 (15.82)	3.29 (9.82)
T9:	Pendimethalin 1.0 kg/ha PRE	1.51 (1.28)	3.73 (12.94)	5.16 (25.65)	4.44 (18.70)	2.28 (4.21)	3.80 (13.41)	4.22 (16.83)	3.18 (9.08)
T10:	Pendimethalin 0.75 kg/ha PRE + 1HW at 21 DAS	1.49 (1.23)	2.09 (3.38)	4.34 (17.81)	3.65 (12.34)	2.33 (4.45)	2.94 (7.65)	4.05 (15.42)	3.05 (8.32)
T11:	Atrazine + pendimethalin (0.4+0.75 kg/ha) PRE	1.47	3.24	4.81	4.01	2.21	3.67	4.14	3.24

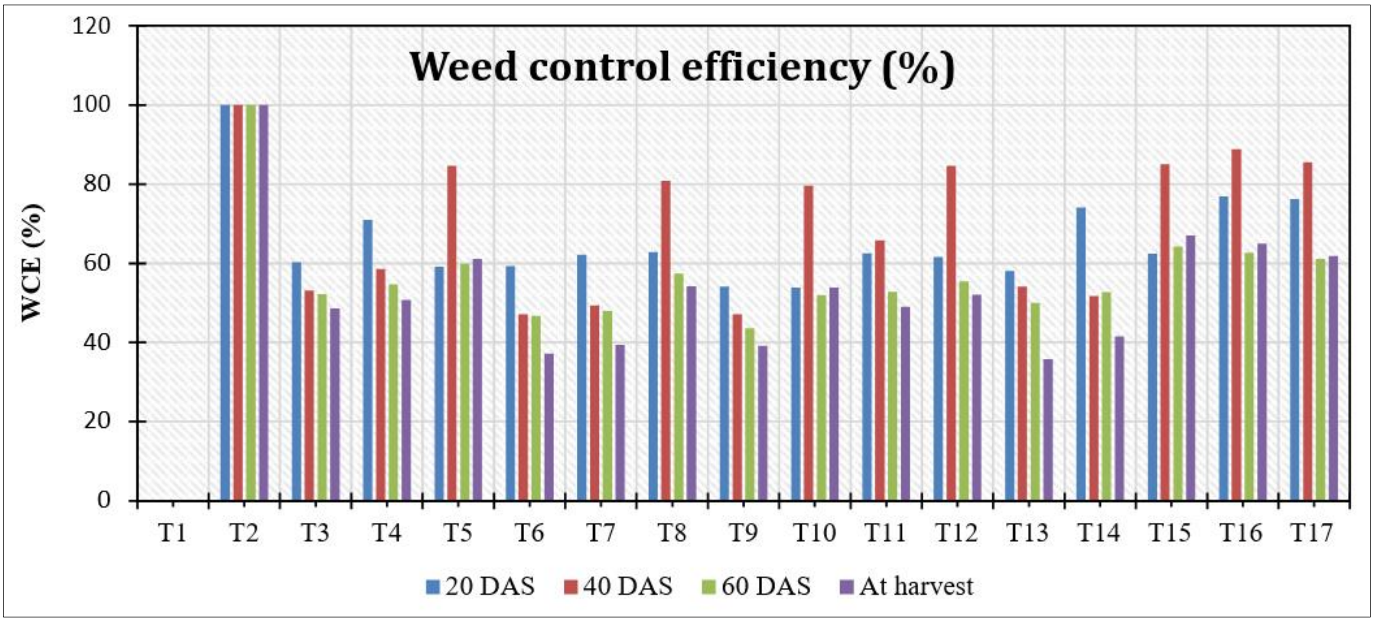
		(1.15)	(9.50)	(22.17)	(15.06)	(3.89)	(12.45)	(16.15)	(9.52)
T12:	Atrazine + pendimethalin (0.4+0.75 kg/ha) PRE + 1HW at 21 DAS	1.46	2.02	4.72	3.99	2.33	2.99	4.13	3.12
		(1.12)	(3.07)	(21.25)	(14.91)	(4.42)	(7.94)	(16.02)	(8.73)
T13:	Tembotrione 80g/ha PoE at 2-4 leaf/10-15 DAS	1.52	3.55	5.25	4.61	2.01	3.91	4.23	3.29
		(1.30)	(11.62)	(26.53)	(20.24)	(2.17)	(14.29)	(16.92)	(9.82)
T14:	Tembotrione 100g/ha PoE at 2-4 leaf/10-15 DAS	1.49	3.74	5.16	4.48	1.73	3.75	4.21	3.18
		(1.21)	(12.97)	(25.68)	(19.05)	(1.99)	(13.08)	(16.70)	(9.08)
T15:	Tembotrione 80g/ha PoE at 2-4 leaf/10-15 DAS + 1 HW at 30 DAS	1.44	1.88	3.91	3.58	1.88	2.68	3.80	2.69
		(1.09)	(2.53)	(14.33)	(11.82)	(2.04)	(6.21)	(13.42)	(6.24)
T16:	Tembotrione 100g/ha PoE at 2-4 leaf/10-15 DAS + 1 HW at 30 DAS	1.46	1.79	4.10	3.54	1.69	2.73	3.82	2.65
		(1.12)	(2.21)	(15.82)	(11.53)	(1.85)	(6.47)	(13.58)	(6.01)
T17:	Two HW/hoeing at 15 and 30 DAS	1.45	2.00	4.20	3.80	1.70	2.69	3.85	2.69
		(1.10)	(2.98)	(16.64)	(13.46)	(1.90)	(6.24)	(13.82)	(6.23)
	CD at 5%	0.05	0.15	0.24	0.20	0.09	0.17	0.20	0.15

Table 4: Effect of various weed control treatments on *D. arvensis* and *T. portucalastrum* dry weight in pearl millet

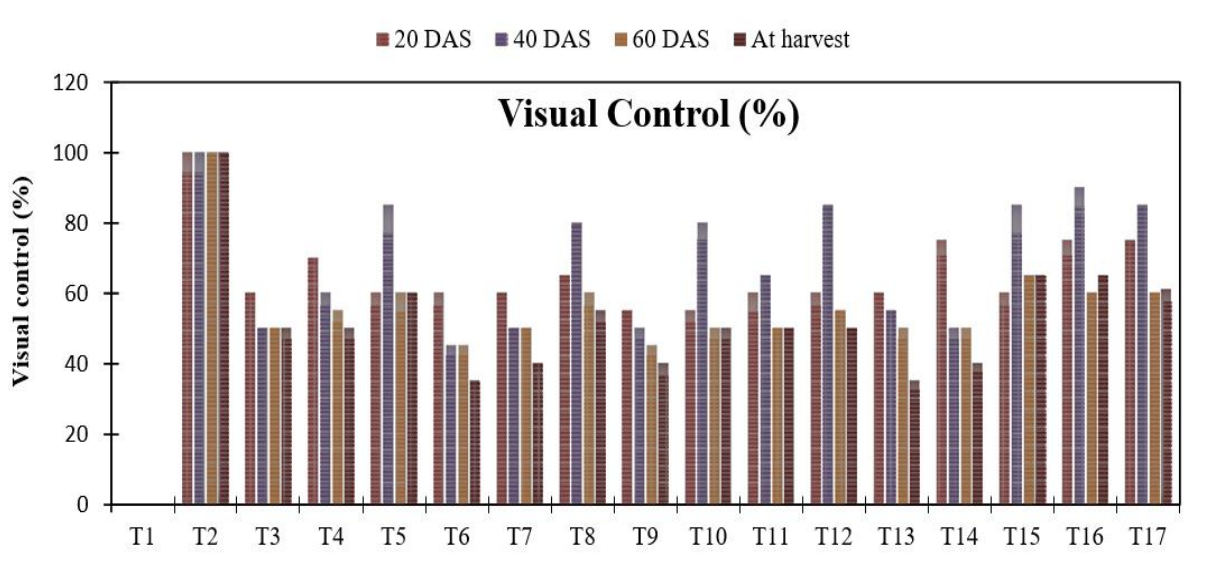
Treatment		**Dry weight of *D. arvensis* (g/m2)**				**Dry weight of *T. portucalastrum* (g/m2)**			
		20 DAS	**40 DAS**	**60 DAS**	**At harvest**	**20 DAS**	**40 DAS**	**60 DAS**	**At Harvest**
T1:	Weedy check	1.88	3.26	3.26	3.26	3.26	5.15	5.44	4.13
		(2.54)	(9.66)	(9.66)	(9.66)	(9.66)	(25.58)	(28.58)	(16.08)
T2:	Weed free	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
		(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
T3:	Atrazine 0.5 kg/haPRE	1.38	2.35	2.35	2.35	2.35	3.95	4.28	3.29
		(0.90)	(4.52)	(4.52)	(4.52)	(4.52)	(14.47)	(17.32)	(9.84)
T4:	Atrazine 0.75 kg/ha PRE	1.32	2.07	2.07	2.07	2.07	3.85	4.26	3.21
		(0.73)	(3.30)	(3.30)	(3.30)	(3.30)	(13.83)	(17.16)	(9.33)
T5:	Atrazine 0.4 kg/ha PRE + 1HW at 21 DAS	1.35	2.41	2.41	2.41	2.41	2.90	4.17	3.11
		(0.83)	(4.82)	(4.82)	(4.82)	(4.82)	(7.41)	(16.41)	(8.66)
T6:	Atrazine 0.5 kg/ha PoE (10-14 DAS)	1.41	2.26	2.26	2.26	2.26	4.08	4.47	3.50
		(0.98)	(4.13)	(4.13)	(4.13)	(4.13)	(15.67)	(18.95)	(11.24)
T7:	Atrazine 0.75 kg/ha PoE (10-14 DAS)	1.30	2.21	2.21	2.21	2.21	4.04	4.50	3.48
		(0.69)	(3.89)	(3.89)	(3.89)	(3.89)	(15.34)	(19.22)	(11.12)
T8:	Atrazine 0.4 kg/ha PoE (10-14 DAS) + 1 HW at 30 DAS	1.33	2.29	2.29	2.29	2.29	3.25	4.10	3.29
		(0.78)	(4.26)	(4.26)	(4.26)	(4.26)	(9.58)	(15.82)	(9.82)
T9:	Pendimethalin 1.0 kg/ha PRE	1.84	2.29	2.29	2.29	2.29	3.80	4.22	3.18
		(2.39)	(4.22)	(4.22)	(4.22)	(4.22)	(13.41)	(16.83)	(9.08)
T10:	Pendimethalin 0.75 kg/ha PRE + 1HW at 21 DAS	1.87	2.24	2.24	2.24	2.24	2.94	4.05	3.05
		(2.48)	(4.03)	(4.03)	(4.03)	(4.03)	(7.65)	(15.42)	(8.32)
T11:	Atrazine + pendimethalin (0.4+0.75 kg/ha) PRE	1.41	2.21	2.21	2.21	2.21	3.67	4.14	3.24
		(0.99)	(3.88)	(3.88)	(3.88)	(3.88)	(12.45)	(16.15)	(9.52)
T12:	Atrazine + pendimethalin (0.4+0.75 kg/ha) PRE + 1HW at 21 DAS	1.40	2.16	2.16	2.16	2.16	2.99	4.13	3.12
		(0.97)	(3.65)	(3.65)	(3.65)	(3.65)	(7.94)	(16.02)	(8.73)
T13:	Tembotrione 80g/ha PoE at 2-4 leaf/10-15 DAS	1.42	2.02	2.02	2.02	2.02	3.91	4.23	3.29
		(1.01)	(3.08)	(3.08)	(3.08)	(3.08)	(14.29)	(16.92)	(9.82)
T14:	Tembotrione 100g/ha PoE at 2-4 leaf/10-15 DAS	1.37	1.94	1.94	1.94	1.94	3.75	4.21	3.18
		(0.88)	(2.76)	(2.76)	(2.76)	(2.76)	(13.08)	(16.70)	(9.08)
T15:	Tembotrione 80g/ha PoE at 2-4 leaf/10-15 DAS + 1 HW at 30 DAS	1.27	1.96	1.96	1.96	1.96	2.68	3.80	2.69
		(0.60)	(2.83)	(2.83)	(2.83)	(2.83)	(6.21)	(13.42)	(6.24)
T16:	Tembotrione 100g/ha PoE at 2-4 leaf/10-15 DAS + 1 HW at 30 DAS	1.28	1.87	1.87	1.87	1.87	2.73	3.82	2.65
		(0.64)	(2.48)	(2.48)	(2.48)	(2.48)	(6.47)	(13.58)	(6.01)
T17:	Two HW/hoeing at 15 and 30 DAS	1.29	1.90	1.90	1.90	1.90	2.69	3.85	2.69
		(0.66)	(2.62)	(2.62)	(2.62)	(2.62)	(6.24)	(13.82)	(6.23)
CD at 5%		0.04	0.09	0.09	0.09	0.09	0.17	0.20	0.15

Table 5: Effect of various weed control treatments on total weed dry weight in pearl millet

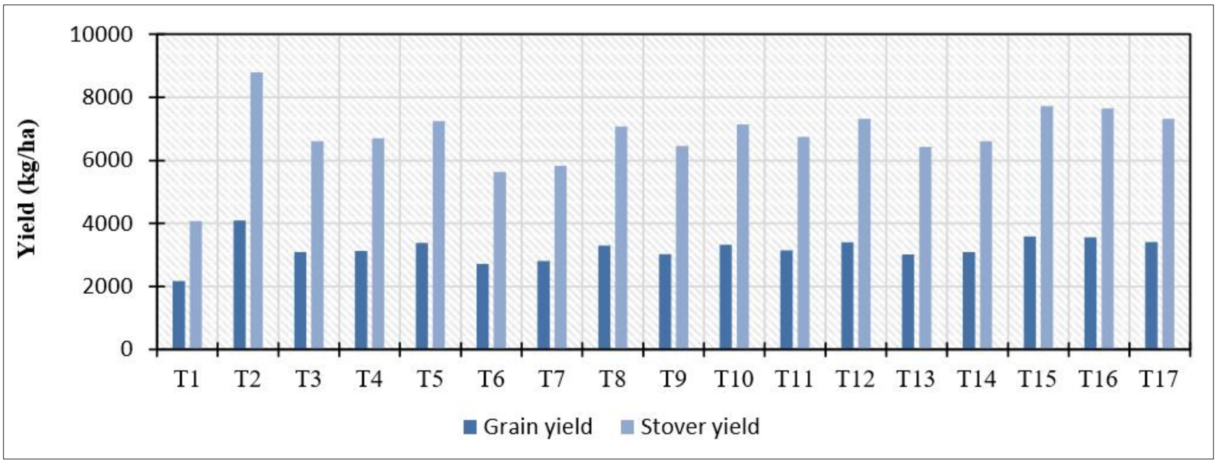
Treatment		Total weed dry wt. of weeds (g/m2)			
		20 DAS	40 DAS	60 DAS	At Harvest
T1:	Weedy check	5.23 (26.41)	8.69 (74.64)	10.99 (119.76)	8.10 (64.60)
T2:	Weed free	1.00 (0)	1.00 (0)	1.00 (0)	1.00 (0)
T3:	Atrazine 0.5 kg/ha PRE	3.39 (10.48)	6.00 (34.97)	7.62 (57.13)	5.85 (33.20)
T4:	Atrazine 0.75 kg/ha PRE	2.94 (7.66)	5.65 (30.95)	7.43 (54.23)	5.72 (31.79)
T5:	Atrazine 0.4 kg/ha PRE + 1HW at 21 DAS	3.34 (10.81)	3.54 (11.50)	7.00 (48.04)	5.11 (25.13)
T6:	Atrazine 0.5 kg/ha PoE (10-14 DAS)	3.43 (10.76)	6.36 (39.46)	8.05 (63.78)	6.45 (40.57)
T7:	Atrazine 0.75 kg/ha PoE (10-14 DAS)	3.32 (9.99)	6.23 (37.81)	7.96 (62.33)	6.33 (39.13)
T8:	Atrazine 0.4 kg/ha PoE (10-14 DAS) + 1 HW at 30 DAS	3.29 (9.80)	3.91 (14.32)	7.20 (50.94)	5.53 (29.58)
T9:	Pendimethalin 1.0 kg/ha PRE	3.62 (12.10)	6.36 (39.46)	8.28 (67.57)	6.35 (39.32)
T10:	Pendimethalin 0.75 kg/ha PRE + 1HW at 21 DAS	3.63 (12.19)	4.03 (15.22)	7.65 (57.50)	5.55 (29.78)
T11:	Atrazine + pendimethalin (0.4+0.75 kg/ha) PRE	3.30 (9.91)	5.15 (25.54)	7.58 (56.49)	5.83 (32.95)
T12:	Atrazine + pendimethalin (0.4+0.75 kg/ha) PRE + 1HW at 21 DAS	3.44 (10.16)	3.53 (11.47)	7.37 (53.39)	5.65 (30.98)
T13:	Tembotrione 80g/ha PoE at 2-4 leaf/10-15 DAS	3.47 (11.06)	5.93 (34.24)	7.80 (59.86)	6.52 (41.47)
T14:	Tembotrione 100g/ha PoE at 2-4 leaf/10-15 DAS	2.80 (6.84)	6.09 (36.08)	7.58 (56.55)	6.22 (37.71)
T15:	Tembotrione 80g/ha PoE at 2-4 leaf/10-15 DAS + 1 HW at 30 DAS	3.31 (9.94)	3.50 (11.23)	6.62 (42.84)	4.72 (21.32)
T16:	Tembotrione 100g/ha PoE at 2-4 leaf/10-15 DAS + 1 HW at 30 DAS	2.66 (6.09)	3.25 (8.33)	6.76 (44.74)	4.85 (22.59)
T17:	Two HW/hoeing at 15 and 30 DAS	2.70 (6.28)	3.43 (10.76)	6.90 (46.56)	5.06 (24.66)
CD at 5%		0.16	0.26	0.38	0.29
S.Em±		0.05	0.09	0.13	0.10



Graph 1: Effect of various weed control treatments on weed control efficiency in pearl millet



Graph 2: Effect of various weed control treatments on visual control in pearl millet



Graph 3: Effect of various weed control treatments on grain and stover yield in pearl millet

Conclusion
All weed control treatments proved effective in controlling weeds in pearl millet and gave significantly higher grain yield over weedy check. Tembotrione 80g/ha PoE at 2-4 leaf/10-15 DAS + 1 HW at 30 DAS (T15) and tembotrione 100g/ha PoE at 2-4 leaf/10-15 DAS + 1 HW at 30 DAS (T16) were found to be most effective and economical weed management treatments in terms of yield, weed control and economic returns for irrigated pearl millet in Haryana state.

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