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Influence of integrated weed management on growth and development of rainfed pigeon pea, *Cajanus cajan* (L.) Millsp.

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ABSTRACT

The experiment was carried out at agronomy Research Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (Uttar Pradesh) India, during the kharif season 2011 - 12. The experiment was laid out in randomized block design having ten treatments i.e. (Fluchloralin @ 1kg a.i ha^{-1} PPI, Fluchloralin @ 1kg a.i ha^{-1} as PPI + one hand weeding at (30DAS), Anilophos @ 1 kg a.i ha^{-1} as PE, Anilophos @1 kg a.i ha^{-1} as PE one hand weeding at (30 DAS). Pendimethalin @ 1 kg a.i ha^{-1} as PE, Pendimethalin @ 1 kg a.i. ha^{-1} as PE + one hand weeding at (30 DAS), one hand weeding at (25 DAS), two hand weeding (25 and 45 DAS), weedy check and weed free check. All the treatments were replicated three times. Among the weed management practices integrated approach i.e pre-emergence application of Pendimethalin @ 1kg a.i ha^{-1} + one hand weeding at 30 DAS has been found promising to reduce the weed density as well as weed dry weight. Pre-emergence application of Pendimethalin @ 1 kg a.i. ha^{-1} + one hand weeding at (30 DAS) proved its superiority over other methods of weed control in respect of all the growth and development characters of pigeon pea crop, which was comparable with weed free check.

***Keywords*:** Crop growth, IWM, rainfed pigeon pea and weed control method

Pulses are the important dry land crops and have played an important role in agriculture production. The symbolic to its nomenclature pulse (P-people, U-umbrella, L-Livestock, S-soil and E-Energy) is indeed a super energy umbrella for people as dietary protein, for livestock as a green nutritious fodder and feed and for soil as a mini-nitrogen plant and green manure (Ali, 1988). Pigeon pea, *Cajanus cajan* (L.) Millsp is an important monsoon grain legume widely cultivated in semi-arid area of India. About 90% of the world production of pigeon pea is contributed by India, occupying more than 10% of the total area under pulses and contributing about 14% of total pulse production. It is cultivated on an area of 4.04 million ha with annual production and productivity of 2.65 million tones and 656 kg ha^{-1} respectively, while, its area, production and productivity in U.P. is 0.32 m ha, 0.29 m tones and 891 kg ha^{-1}, respectively (Anonymous, 2012-2013).

The system aims to maintain the crop weed balance will be in farmer of the crop. This can be done by adopting integrated method of weed management (IWM) which combines different direct and indirect methods of weed control. The direct method includes cultural, manuals, mechanical and chemical weed control practices while indirect method of weed control include preventive, cultivars, land preparation, plant stand establishment, fertilizer, water management and crop rotation etc. Development and implementation of IWM strategies is becoming more important. The considering recent environmental and social realities associated with traditional cropping systems, better systems, better use of plant density and row spacing along with reduced dose of herbicide application may be one way to make crops more competitive with weed and better weed control efficiency at early crop growth stages (Swanton and Murphy, 1996). Integrated weed management is a system approach where by whole land use planning is done in advance to minimize the adverse effect of weeds in aggressive forms and give a strongly competitive advantage to crop plant over the weeds (Gupta.1998). The weeds are serious problem in pigeon pea and drastically reduce the yield; hence, for their control different methods (mechanical, cultural and chemical) are used, due to shortage of laborer's. First two methods are rarely used while herbicides are not sustainable over long periods (Narwal, 1996). Innumerable and practical experience shows that no single methods will give a continuous and effective control of weeds in all situations therefore, integrated weed management (IWM) aimed to bring down the intensity of weed growth to the economically insignificant level with minimum influence on environmental pollution. The combined application of agronomic, mechanical, biological and chemical methods usually referred to the IWM which is one of potential leavers for providing the optimum condition for better crop growth and adverse environmental to weed growth (Readdy, 2007).

MATERIALS AND METHODS

The field experiment was conducted during *Kharif* season 2011-12 at the Agronomy Research Farm of Narendra Deva University of Agriculture & Technology,

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Kumarganj, Faizabad (U.P.). Geographically, experimental site is situated at 26^0 47' N latitude, 82^0 12' E longitudes and at an altitude of 113 meters above the mean sea level in the North Indo-Gangetic plain. The centre enjoys the sub-tropical climate often subjected to extremes of weather condition *i.e*. cold winter and hot summer. Faizabad district enjoys sub humid climate receiving average annual rainfall of about 1100 mm. On an average, about 85% of the total rainfall received during monsoon period *viz*., June to September, however, occasionally 5-10% showers occur during winter season. In this district normally, onset of monsoon is taken place during 3rd week of June and it remains active up to the end of September or first week of October. On the basis of mechanical analysis, the soil has been classified as silt loam. The chemical analysis shows that the soil was medium in fertility status and saline in soil nature.

The experiment was laid out in Ten treatments Fluchloralin (1.0 Kg *a.i.* ha^{-1}) PPI, Fluchloralin + one hand weeding (at 30 DAS), Anilophos (1.0Kg *a.i.* ha^{-1}) PE, Anilophos + one hand weeding (at 30 DAS), Pendimethalin (1.0 Kg *a.i.* ha^{-1}) PE, Pendimethalin + one hand weeding (at 30 DAS), One hand weeding (at 25 DAS), Two hand weeding (at 25 and 45 DAS), Weedy check and Weeds free check of various methods of weed control were tested in randomized block design with 3 replications. In herbicidal treatments, Fluchloralin (45% EC) @ 1 kg *a.i.* ha^{-1} was applied as PPI. The herbicide was sprayed with the help of a hand operated Knapsack sprayer fitted with flat fan nozzle using 600 liters of water per hectare. Anilophos (24% EC) was sprayed as pre-emergence (PE) into soil. Pendimethalin (30% EC) @ 1.0 kg/ha was applied as pre-emergence. Hand weeding was done with the help of a hand chisel locally known as khurpi as per treatments. Application of fertilizers an amount of 18 kg N, 46 kg P_2O_5 and 20 kg K_2O ha^{-1} was applied. Full quantity of fertilizer was applied basal through, Diammonium phosphate (18% N, 46% P_2O_5) and Muriate of potash (60%K_2O) just before sowing.

To see the effect of different treatments on weeds and crop, a number of observations on growth and yield attribute of crop and weed ecology were recorded at different stages of crop growth. Since it is very difficult to study all the individuals of plant population, five plants from each plot were selected randomly and tagged for further study. The data recorded in respect of different observations in the present study were analyzed statistically with the help of computer following the programme for Randomized Block Design as suggested by Cochran and Cox (1957). The standard error of means was calculated in each case and critical a difference at 5% level was worked out for comparing the treatment means, wherever, F test was found significant.

RESULTS AND DISSCUSSION

Weed flora

The major weeds noted in the weedy check plot of experimental field were the *Dactyloctenium aegyptium* and *Cynodon dactylon* as grassy weeds, *Triantima portulocastrum and Ageratum conyzoides* as broad-leaved weeds and *Cyperus* spp. as sedge (Table 1). Similar weed flora in pigeon pea crop under normal sown condition has also been reported by many scientists working in different agro-climatic zones of the country like *Tiwari et al.* (1992).

Weed density

The effects of different weed control measures on density of different weed species at 30 DAS, 60 DAS, 90 DAS and at harvest have that application of various treatments showed significant effect on controlling various types of weeds like grassy, broad leaved weed, sedges (Table 2, 3, 4 and 5). Application of pendimethalin @ 1.0 kg *a.i.* ha^{-1} as PE at 30 DAS found the most affective weedicide in controlling various weeds like grassy weeds *viz., D. aegyptium* and *C. dactdylon*. Similar pattern was also followed in broad leaved weeds and sedges. The least effective weedicide was found anilophos in controlling the various weeds in pigeon pea at 30 DAS.

Data clearly indicated that pendimethalin @ 1.0 kg *a.i.* ha^{-1} + one hand weeding found most effective in controlling various weeds at 60 DAS and anilophos was found least effective weedicide in controlling various weeds. Pendimethalin followed by fluchloralin was found most effective in controlling various weeds at 90 DAS. Anilophos @ 1.0 kg *a.i.* ha^{-1} was treated as least effective weedicide in minimizing various weeds. The maximum weed population in weedy check like grassy, broad leaved weed, sedges and also in totality was noticed. Pendimethalin @ 1 kg + one hand weeding at 30 days was found most effective in controlling various weeds at harvest stage. The least effective weedicide was found anilophos in controlling various weeds. The maximum weed population was observed in weedy check. Similar results have also been reported by Gangwar (1993) and Shrivastava *et al*. (2001).

Dry matter of weeds

The data of dry mater of weeds as affected by various weed control treatment are given in (Table 6) that significantly lowest dry matter of weeds was obtained by the application of pendimethalin @1.0 kg *a.i.* ha^{-1}+one hand weeding at 30 DAS while maximum dry matter of weeds was noted in plot treated with Anilophos @ 1.0 kg *a.i.* ha^{-1} at all the growth stages of crop i.e. 30, 60, 90 DAS and at harvest stages. The maximum dry matter of weeds was noted in weedy check at all the growth stages

Table 1: Weed flora in experimental crop

S.No	Weed species	Common name	Family	Habitat
A	**Grassy weeds**			
1	*Dactyloctenium aegyptium*	Crow foot grass	Gramineae	Annual
2	*Cynodan dactylon*	Bermuda grass	Gramineae	Perennial
B	**Broad leaved weeds**			
1	*Trianthema partulacastrum*	Horsepurslane ltsit	Aizoaceae	Annual
2	*Ageratum conyzoides*	Billgoat weed	Compositae	Annual
C.	**Sedge**			
1	*Cyperus* spp.	Motha	Cyperaceae	Perennial
D	**Other weeds**			
1	*Echinochloa* spp.	Barnyard grass	Gramineae	Annual
2	*Panicum repens*	Panic grass	Gramineae	Annual
3	*Celosia argentea*	Cock's comb, salara	Amaranthaceae	Annual
4	*Eclipta alba*	Bhangra	Compositae	Annual
5	*Fimbristyllis* spp.	Choti booin	Cyperaceae	Annual

Table 2: Effect of various weed control treatments on weed density (number m^{-2}) of different weed species at 30 DAS of pigeon pea

Treatments	*Grassy*		*Broad leaved*		*Sedges*	Others	Total
	D. aegyptium	***C. dactylon***	***T. portulacastrum***	***A. conyzoides***	***Cyperus spp.***		
T_1: Fluchloralin @ 1 kg *a.i.* ha^{-1} as PPI	2.68 (6.20)	2.53 (5.40)	2.64 (6.00)	2.59 (5.70)	2.89 (7.90)	3.07 (8.40)	6.06 (35.70)
T_2: T_1 + one HW at 30 DAS	2.55 (5.50)	2.41 (4.80)	2.24 (4.00)	2.41 (4.80)	2.93 (7.60)	2.68 (6.20)	6.02 (35.30)
T_3: Anilophos @ 1 kg *a.i.* ha^{-1} as PE	2.92 (7.50)	2.72 (6.40)	2.57 (5.60)	2.68 (6.20)	3.02 (8.10)	2.95 (7.70)	6.52 (41.50)
T_4: T_3 + one HW at 30 DAS	2.77 (6.70)	2.72 (6.40)	2.39 (4.70)	2.72 (6.40)	3.33 (10.10)	2.90 (7.40)	6.53 (41.70)
T_5: Pendimethalin @ 1 kg *a.i.* ha^{-1} as PE	2.55 (5.50)	2.43 (4.90)	2.49 (5.20)	2.30 (4.30)	2.81 (6.90)	2.55 (5.50)	5.55 (30.30)
T_6: T_5 + one HW at 30 DAS	2.34 (4.50)	2.21 (3.90)	2.37 (4.60)	2.55 (5.50)	2.68 (6.20)	2.47 (5.50)	5.67 (31.20)
T_7: One hand weeding at 25 DAS	2.00 (3.00)	1.82 (2.30)	1.41 (1.00)	1.73 (2.00)	1.90 (2.60)	1.92 (2.70)	3.82 (13.60)
T_8: Two HW at 25 and 45 DAS	1.67 (1.80)	1.73 (2.00)	1.61 (1.60)	1.70 (1.90)	2.10 (3.40)	1.82 (2.30)	3.74 (13.00)
T_9: Weedy check	6.06 (35.90)	5.59 (30.40)	4.91 (23.20)	4.50 (19.40)	5.93 (34.40)	6.17 (37.30)	13.46 (180.60)
T_{10}: Weed free check	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
SEm±	**0.12**	**0.10**	**0.09**	**0.08**	**0.11**	**0.11**	**0.26**
LSD (0.05)	**0.37**	**0.30**	**0.27**	**0.24**	**0.33**	**0.34**	**0.76**

Note: HW= hand weeding

Table 3: Effect of various weed control treatments on weed density (No. m^{-2}) of different weed species at 60 DAS of pigeon pea

Treatments	*Grassy*		*Broad leaved*		*Sedge*	Others	Total
	D. aegyptium	***C. dactylon***	***T. portulacastrum***	***A. conyzoides***	***Cyperus spp.***		
T_1: Fluchloralin @ 1 kg *a.i.* ha^{-1} as PPI	3.07 (8.40)	3.11 (8.70)	2.79 (6.80)	2.98 (7.90)	3.73 (12.90)	3.15 (8.90)	7.39 (53.60)
T_2: T_1 + one HW at 30 DAS	2.19 (3.80)	2.37 (4.60)	2.12 (3.50)	2.05 (3.20)	2.64 (6.00)	2.55 (5.50)	5.25 (26.60)
T_3: Anilophos @ 1 kg *a.i.* ha^{-1} as PE	3.27 (9.70)	3.19 (9.20)	2.86 (7.20)	3.13 (8.80)	3.77 (13.20)	3.27 (9.70)	7.67 (57.80)
T_4: T_3 + one HW at 30 DAS	2.12 (3.50)	2.21 (3.90)	2.41 (4.80)	2.28 (4.20)	2.98 (7.90)	2.81 (6.90)	5.67 (31.20)
T_5: Pendimethalin @ 1 kg *a.i.* ha^{-1} as PE	2.91 (7.50)	3.02 (8.10)	2.50 (5.70)	2.72 (640)	3.71 (12.80)	3.31 (8.80)	7.09 (49.30)
T_6: T_5 + one HW at 30 DAS	2.07 (3.30)	2.34 (4.50)	2.17 (3.70)	2.02 (3.10)	2.41 (4.80)	2.57 (5.60)	5.00 (24.00)
T_7: One hand weeding at 25 DAS	3.11 (8.70)	2.90 (7.50)	2.70 (6.30)	2.61 (5.80)	3.30 (9.98)	2.97 (7.80)	6.82 (45.50)
T_8: Two HW at 25 and 45 DAS	2.28 (4.20)	2.00 (3.00)	1.73 (2.00)	2.05 (3.20)	2.05 (3.20)	1.87 (2.50)	4.38 (18.20)
T_9: Weedy check	6.05 (35.80)	6.27 (38.50)	4.84 (22.60)	5.04 (24.50)	6.48 (41.20)	6.47 (41.10)	14.24 (203.00)
T_{10}: Weed free check	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
SEm±	**0.11**	**0.12**	**0.09**	**0.09**	**0.12**	**0.12**	**0.27**
LSD (0.05)	**0.33**	**0.34**	**0.27**	**0.28**	**0.37**	**0.36**	**0.81**

Table 4: Effect of various weed control treatments on weed density (No. m^{-2}) of different weed species at 90 DAS of pigeon pea

Treatments	*Grassy*		*Broad leaved*		*Sedge*	Others	Total
	D. aegyptium	***C. dactylon***	***T. portulacastrum***	***A. conyzoides***	***Cyperus* spp.**		
T_1: Fluchloralin @ 1 kg *a.i.* ha^{-1} as PPI	3.15 (8.90)	3.18 (9.10)	3.19 (9.20)	3.02 (8.10)	3.89 (14.10)	3.35 (10.20)	7.78 (59.60)
T_2: T_1 + one HW at 30 DAS	2.93 (7.60)	3.08 (8.50)	2.77 (6.70)	2.61 (5.80)	3.45 (10.90)	3.13 (8.80)	6.97 (47.70)
T_3: Anilophos @ 1 kg *a.i.* ha^{-1} as PE	3.33 (10.10)	3.27 (9.70)	2.92 (7.50)	3.19 (9.20)	4.16 (16.30)	3.43 (10.80)	8.04 (63.70)
T_4: T_3 + one HW at 30 DAS	2.98 (7.90)	2.74 (6.50)	2.92 (7.50)	2.72 (6.40)	3.65 (12.30)	3.15 (8.90)	7.11 (49.50)
T_5: Pendimethalin @ 1 kg *a.i.* ha^{-1} as PE	3.14 (8.90)	3.11 (8.70)	2.98 (7.90)	2.70 (6.30)	3.79 (13.40)	3.28 (8.90)	7.35 (53.10)
T_6: T_5 + one HW at 30 DAS	2.95 (7.70)	2.72 (6.40)	2.47 (5.10)	2.51 (5.30)	3.33 (10.10)	3.10 (8.60)	6.64 (43.10)
T_7: One hand weeding at 25 DAS	3.11 (8.70)	3.22 (9.40)	3.10 (8.60)	3.05 (8.30)	4.15 (16.20)	3.70 (12.70)	8.05 (63.90)
T_8: Two HW at 25 and 45 DAS	2.79 (6.80)	2.86 (7.20)	2.79 (6.80)	2.83 (7.00)	3.53 (11.50)	3.16 (9.00)	7.02 (48.30)
T_9: Weedy check	6.35 (39.50)	6.52 (41.70)	5.12 (25.40)	4.83 (22.50)	6.81 (45.70)	6.43 (40.60)	14.60 (213.40)
T_{10}: Weed free check	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
SEm±	**0.11**	**0.12**	**0.10**	**0.09**	**0.13**	**0.12**	**0.29**
LSD (0.05)	**0.33**	**0.37**	**0.29**	**0.28**	**0.40**	**0.37**	**0.86**

Table 5: Effect of various weed control treatments on weed density (No. m^{-2}) of different weed species at harvest stage of pigeon pea

Treatments	*Grassy*		*Broad leaved*		*Sedge*	Others	Total
	D. aegyptium	***C. dactylon***	***T. portulacastrum***	***A. conyzoides***	***Cyperus* spp.**		
T_1: Fluchloralin @ 1 kg *a.i.* ha^{-1} as PPI	2.72 (6.40)	2.70 (6.30)	2.55 (5.50)	1.00 (0.00)	2.92 (7.50)	2.90 (7.40)	5.84 (33.10)
T_2: T_1 + one HW at 30 DAS	2.41 (4.80)	2.21 (3.90)	2.17 (3.70)	1.00 (0.00)	2.64 (6.00)	2.51 (5.30)	4.97 (23.70)
T_3: Anilophos @ 1 kg *a.i.* ha^{-1} as PE	2.63 (5.90)	2.70 (6.30)	2.65 (6.00)	1.00 (0.00)	3.00 (8.00)	3.15 (8.90)	6.00 (35.00)
T_4: T_3 + one HW at 30 DAS	2.41 (4.80)	2.49 (5.20)	2.07 (3.30)	1.00 (0.00)	2.81 (6.90)	2.86 (7.20)	5.33 (27.40)
T_5: Pendimethalin @ 1 kg *a.i.* ha^{-1} as PE	2.64 (6.00)	2.57 (5.60)	2.28 (4.20)	1.00 (0.00)	2.95 (7.70)	2.84 (7.10)	5.71 (30.60)
T_6: T_5 + one HW at 30 DAS	2.19 (3.80)	2.12 (3.50)	2.00 (3.00)	1.00 (0.00)	2.24 (4.00)	2.45 (5.00)	4.50 (19.30)
T_7: One hand weeding at 25 DAS	3.05 (8.30)	3.18 (9.10)	2.74 (6.50)	1.00 (0.00)	3.35 (10.20)	3.10 (8.60)	6.56 (42.00)
T_8: Two HW at 25 and 45 DAS	2.70 (6.30)	2.63 (5.90)	2.43 (4.90)	1.00 (0.00)	3.05 (8.30)	2.88 (7.30)	4.55 (19.70)
T_9: Weedy check	6.09 (36.30)	6.16 (37.10)	4.46 (19.00)	1.00 (0.00)	6.20 (37.60)	5.98 (35.00)	12.82 (164.40)
T_{10}: Weed free check	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
SEm±	**0.11**	**0.11**	**0.08**	**0.00**	**0.12**	**0.11**	**0.24**
LSD (0.05)	**0.33**	**0.33**	**0.25**	**0.00**	**0.34**	**0.33**	**0.73**

Table 6: Effect of various weed control treatments on dry matter of total weeds (g m^{-2}) at different stages of pigeon pea

Treatments	30 DAS	60 DAS	90 DAS	At harvest
T_1: Fluchloralin @ 1 kg *a.i.* ha^{-1} as PPI	5.37 (27.90)	5.85 (33.20)	6.19 (37.30)	5.60 (30.32)
T_2: T_1 + one HW at 30 DAS	5.19 (26.00)	4.50 (19.31)	5.16 (25.70)	4.98 (23.80)
T_3: Anilophos @ 1 kg *a.i.* ha^{-1} as PE	5.87 (33.50)	6.42 (40.20)	6.56 (42.00)	5.77 (32.31)
T_4: T_3 + one HW at 30DAS	5.88 (33.60)	4.80 (22.00)	5.52 (29.50)	5.16 (25.60)
T_5: Pendimethalin @ 1 kg *a.i.* ha^{-1} as PE	5.03 (24.30)	5.52 (29.50)	5.97 (34.71)	5.40 (28.22)
T_6: T_5 + one HW at 30 DAS	5.01 (24.10)	4.36 (18.02)	4.92 (23.25)	4.62 (20.35)
T_7: One hand weeding at 25 DAS	3.08 (8.50)	5.80 (32.60)	6.65 (43.20)	6.25 (38.07)
T_8: Two HW at 25 and 45 DAS	3.00 (8.00)	3.90 (14.20)	5.06 (24.65)	4.67 (20.80)
T_9: Weedy check	13.60 (185.00)	15.15 (230.00)	15.85 (251.80)	13.96 (195.00)
T_{10}: Weed free check	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
SEm±	**0.25**	**0.28**	**0.30**	**0.26**
LSD (0.05)	**0.76**	**0.84**	**0.88**	**0.78**

Table 7: Effect of weed control treatments on weed control efficiency (WCE) and weed index (WI) at harvest; plant population and plant height at various growth stages of pigeon pea

Treatments	WCE (%)	WI (%)	Plant population per running meter				Plant height (cm)	
			20 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
T_1: Fluchloralin @ 1 kg *a.i.* ha^{-1} as PPI	84.45	23.79	6.00	5.00	30.28	60.20	98.52	169.32
T_2: T_1 + one HW at 30 DAS	87.79	13.25	5.98	5.17	30.78	63.59	105.85	193.51
T_3: Anilophos @ 1 kg *a.i.* ha^{-1} as PE	83.43	31.91	5.95	4.86	30.25	59.20	97.62	166.68
T_4: T_3 + one HW at 30DAS	86.87	22.55	6.00	4.89	30.61	59.90	100.15	171.30
T_5: Pendimethalin @ 1 kg *a.i.* ha^{-1} as PE	85.53	16.67	5.89	5.10	30.61	62.77	101.3	177.38
T_6: T_5 + one HW at 30 DAS	89.56	5.59	6.00	5.31	30.94	65.57	109.16	199.22
T_7: One hand weeding at 25 DAS	80.48	31.16	5.80	4.78	29.54	59.00	95.08	160.19
T_8: Two HW at 25 and 45 DAS	89.33	6.48	6.00	5.30	30.43	64.90	105.90	190.59
T_9: Weedy check	0.00	44.06	5.65	4.61	29.00	48.35	83.80	153.19
T_{10}: Weed free check	100.00	0.00	6.00	5.81	30.58	67.23	113.57	207.62
SEm±			**0.37**	**0.20**	**0.55**	**0.87**	**0.51**	**1.17**
LSD (0.05)			**NS**	**0.60**	**NS**	**2.58**	**1.52**	**3.48**

Table 8: Effect of weed control treatments on branches plant^{-1} and dry matter accumulation at various growth stages of pigeon pea

Treatments	Number of branches plant^{-1}				Dry matter accumulation (g plant^{-1})			
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
T_1: Fluchloralin @ 1 kg *a.i.* ha^{-1} as PPI	1.55	3.86	12.04	15.01	1.92	18.10	86.85	300.0
T_2: T_1 + one HW at 30 DAS	1.54	4.42	13.76	17.16	1.91	18.38	105.55	350.0
T_3: Anilophos @ 1 kg *a.i.* ha^{-1} as PE	1.52	3.76	11.89	14.60	1.90	18.61	86.34	290.0
T_4: T_3 + one HW at 30DAS	1.54	3.86	12.00	14.83	1.91	19.49	91.93	343.0
T_5: Pendimethalin @ 1 kg *a.i.* ha^{-1} as PE	1.59	4.05	12.61	15.73	1.94	21.26	96.66	320.0
T_6: T_5 + one HW at 30 DAS	1.60	4.65	14.47	18.05	1.95	22.37	116.48	368.0
T_7: One hand weeding at 25 DAS	1.57	3.70	11.42	14.33	1.88	18.49	85.49	253.33
T_8: Two HW at 25 and 45 DAS	1.57	4.55	14.19	17.69	1.93	21.93	115.19	365.0
T_9: Weedy check	1.47	3.36	9.89	11.58	1.85	16.84	70.71	225.0
T_{10}: Weed free check	1.69	4.74	14.76	18.41	2.00	22.81	123.18	370.0
SEm±	**0.06**	**0.23**	**0.40**	**0.50**	**0.03**	**0.82**	**4.53**	**9.85**
LSD (0.05)	**NS**	**0.68**	**1.18**	**1.49**	**NS**	**2.43**	**13.47**	**29.25**

of pigeon pea. The dry matter of total weeds was increased with advancement of crop age and found highest at 90 days; thereafter it was decreased at harvest stage of the crop. The rate of increased in dry weight accumulation as per the advancement in age of crop was due to emergence of the new weed species. It was observed that at harvest stage, total dry weight of weeds was reduced in all the treatments. These results are in conformity with those reported by Kumar *et al.* (1994).

Weed control efficiency and weed index

The data recorded on weed control efficiency and weed index have showed in (Table 7) the treated plots the maximum weed control efficiency was calculated with the application of pendimethalin @ 1.0 kg *a.i.* ha^{-1} + one hand weeding at 30 DAS. The minimum weed control efficiency with application of noted anilophos @ 1 kg *a.i.* ha^{1}.The data pertaining to weed index given in showed that minimum weed index was recorded in pendimethalin + one hand weeding at 30 days while maximum weed index was recorded in the plots treated with anilophos @ 1 kg *a.i.* ha^{-1} as compared to other treated plots. The maximum weed index was obtained in weed check. It is well known fact that the weed index (WI) is directly correlated with WCE if in a particular treatment there was that highest WCE (%) it means weeds

have been controlled very effectively and reduction in yield was very less, because there is an inverse relationship between WCE (%) and weed index (WI). However, highest seed yield was recorded with weed free check and lowest with weedy check because there was no competition in weed free check and 100% competition between crop and weeds in weedy check. These results are in agreement with the findings of Srivastava *et al.* (2001) and Singh and Sekhon (2013).

Plant populations and plant height

It is evident from the data presented in (Table 7) that the plant population running^{-1} meter was not affected significantly at 20 DAS with the application of various weed control treatments. However, at harvest the plant population affected due to various weed control treatments and it is observed that significantly higher plant population running^{-1} meter was needed with the application pendimethalin @ 1 kg *a.i.* ha^{-1} + one hand weeding at 30 DAS. The minimum plant population was recorded in with one hand weeding at 25 DAS treated plots. This was comparable with weedy check at harvest stage of crop. The data presented to plant height as affected by various treatments indicated (Table 7) that plant height at 30 DAS was not affected significantly due to various weed control treatments. However, significant variation in plant height was observed at 60 DAS, 90 DAS and at harvest stages of the crop. The maximum plant height was recorded at all the stages of growth with the application of pendimethalin @ 1.0 kg *a.i.* ha^{-1} + one hand weeding at 30 DAS, which was at par with weed free check. The minimum plant height was recorded at the various stages of crop growth in the plots treated with one hand weeding at 25 DAS, which was followed to the weedy check treatment. There was very less competition between crop and weeds; because of the better control of weeds under the above treatments which resulted in the taller plants. Similar results have also been reported by Dhage *et al.* (2008) and Reddy *et al. (*2008).

Number of branches plant^{-1} and dry matter accumulation (g plant^{-1})

The data recorded on number of branches plant^{-1} presented in (Table 8) that non-significant variation was observed at 30 DAS while at remaining growth stages a significant variation was noticed in number of branches plant^{-1} due to various weed control treatments. The maximum number of branches plant^{-1} was recorded with the application of pendimethalin @ 1 kg *a.i.* ha^{-1} + one hand weeding at 30 DAS at 60, 90 DAS and at harvest stages of crop growth, which was comparable with to the weed free treatment. However, minimum number of branches plant^{-1} was recorded with one hand weeding treatment, which was next to weedy check. This may be because of the facts that those reatments have better WCE, had more horizontal crop growth and growth the greater number of branches plant^{-1}. After the weed free treatment pendimethalin @ 1.0 *a.i.* ha^{-1} + one hand weeding at 30 DAS produced a greater number of branches plant^{-1} at all the stages of crop growth. Similar results have also been reported by Upadhyay (2002) and Reddy *et al.* (2008).

It is evident from the data presented in (Table 8) that dry matter accumulation at 30 DAS was not affected significantly, due to various treatments of weed control, while significant variation was observed at remaining growth stages of the crop. The maximum dry matter accumulation was achieved in the plots treated with pendimethalin @ 1 kg *a.i.* ha^{-1}+one hand weeding at 30 DAS at all the growth stages of the crop which was followed by weed free check. The minimum dry matter accumulation was noticed with the application of one hand weeding at 25 DAS which was followed to weedy check at all the growth stages of crop. Crop dry matter is a net result of photosynthesis, which remained in balance after respiration process. The growth attributes like plant height and number of branches plant^{-1} have the direct contribution in dry matter accumulation (g plant^{-1}), while density and the dry weight of the weeds have a strongly negative correlation with dry mater accumulation of pigeon pea. Therefore, those treatments reduced the density and dry weight of weeds were more effectively provided a more favorable micro-environment to enhance the crop growth and ultimately having more dry mater plant^{-1} in the respective treatments. Similar results have also been reported by Singh and Sekhon (2013).

Infestation of weeds may be one of important limiting factors responsible for low yield and hampers crop growth and development particularly in rainfed area of India. Based on present experimental results, it may be concluded that the pendimethalin 1.0 kg *a.i.* ha^{-1} + one hand weeding at 30 DAS was found most suitable treatment for effective control of complex weed flora in rainfed pigeon pea.

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