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Influence of integrated weed management practices on weed dynamics, growth and yield of chickpea (*Cicer arietinum* L.)

Arashdeep Singh and Mohinder Lal

Abstract
A field experiment was conducted during *Rabi* season of 2017-18 at the Campus for Agricultural Research and Advanced Studies Dhablan of the G.S.S.D.G.S. Khalsa College Patiala, Punjab. To find out most suitable integrated weed management practices for control of weeds in chickpea under irrigated condition of Punjab. Integrated weed management significantly influenced the weed dynamics, growth and yield of chickpea crop. Weed parameter like total weed population (m-2) and weed dry weight (g) m-2, except weed control efficiency (%) was recorded significantly minimum in treatment T2 (Weed free) which was followed by treatment T4 (Two hand weeding at 25 and 45 DAS) and T6 (Pendimethalin @ 750g ha-1 *fb* one hand weeding at 25 DAS). All the growth parameters (plant height (cm), number of branches plant-1 and dry weight (g) plant-1) and yield attributes (number of pods plant-1, number of seeds pod-1, test weight (g) and seed yield (q ha-1 were significantly higher in treatment T2 (Weed free) which was followed by treatment T4 (Two hand weeding at 25 and 45 DAS) and T6 (Pendimethalin @ 750g ha-1 *fb* one hand weeding at 25 DAS).

Keywords: chickpea, weed, integrated weed management, pendimethalin

Introduction
Chickpea (*Cicer arietinum* L.) is a legume crop which belongs to *fabaceae* family, sub-family *faboideae.* It is commonly known as Gram or Bengal gram (English), Chana (Hindi). Chickpea is mostly used as salad and to cook various dishes.It is a key source of protein and plays an important role in human nutrition. Pulses are highly rich source of protein, carbohydrates, minerals, important vitamins and fiber. These have great importance in the human dietary and in agricultural pulse production. Similar to all other pulses chickpea is also a great source of protein. It contains high level of protein (18-22%), fat (7-10%), carbohydrate (60-65%), minerals (3-5%) and rich in vitamin B and C.

In India, the area under chickpea cultivation is 8.93 million hectares and the production is 8.36 million tonnes with productivity 995 kg ha-1 (Directorate of pulses development, DAC&FW 2016-17). In Punjab state it is grown on an area of 1.9 thousand hectares with production of 2.4 thousand tonnes with an average yield of
12.82 q ha-1 (Anonymous 2017-18) [2]. The total productivity of chickpea is much below its actual requirement and there is great need to enhance its area as well as productivity.

The basic concept underlying the principle of integrated weed management is integration and implementation of effective weed control methods with due consideration of economical and ecological consequences. The main objectives of integrated weed management are to eradicate the unwanted plants and produce the maximum crop production at a lower cost under a given agro-ecosystem. Dependence on a single component of weed management i.e. mechanical weeding (hoeing) as well as on chemicals (weedicides) has their own limitations, so integration of both the component shows to be eco-friendly and most effective technique of weed management.

Yield losses in chickpea crop due to weeds ranges from 22-100%. Bhalla *et al*. (1998) [4] found that herbicide treatment gave 50-64% weed control with an increase in yield. The extent of losses due to weeds in chickpea depends upon the type of weed flora and period of crop weed competition.

For obtaining good crop yield, weeds should be eradicated before critical period of crop-weed competition. In chickpea initial 60 days period is considered to be the critical for crop-weed competition (Singh and Singh., 1992) [10].

Materials and methods

The field experiment was laid out in randomized block design with 10 different treatments with 3 replications. The soil of experimental field was clay, soil pH 7.3, medium in organic carbon (0.52%), low in available nitrogen (262 kg ha-1), medium in available phosphorus (22.6 kg ha-1) and potassium (129 kg ha-1). The plant material comprised of chickpea var. PBG 7 as per treatment was sown on 23th November, 2017 and harvested at 4th April 2018. The crop was planted maintaining a distance of 30 cm and 10 cm between the row and plants respectively. Weed population were counted from a quadrate measuring 1 m2 from two locations in each plot at 30, 60, 90 DAS and at harvest and was expressed as number of plants m-2. Five representative sample plants were randomly selected from each of the plots plant height was recorded in cm. The numbers of branches per plant were counted from the five randomly selected sample plants and the values of these were summed up and averaged. To study the dry weight of five plants were collected from the sampling rows of each plot at 30 days interval from sowing till harvest of the crop. Harvested produce from the net plot was threshed manually and grain yield recorded in kilograms. It was then converted to q ha-1 by bringing the produce at 14 per cent moisture content.

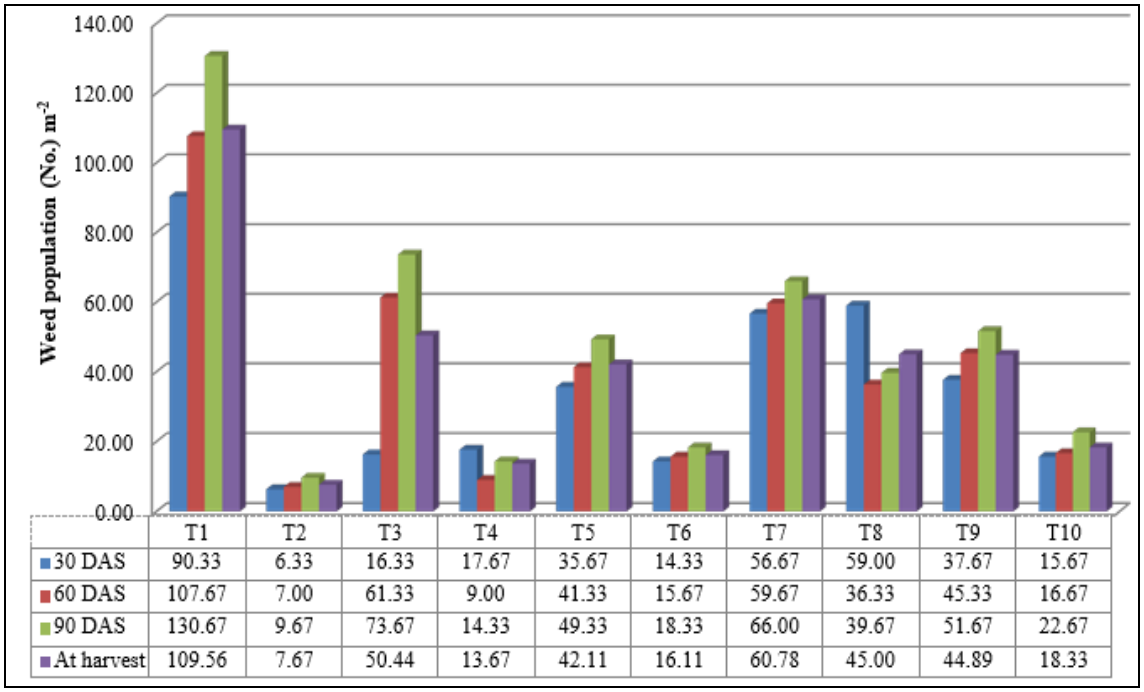
Results and Discussion

Integrated weed management has significantly effect on weed, growth and yield of chickpea crop. The result of present study showed that significantly lower weed populations (6.33, 7.00, 9.67 and 7.67) were recorded at all the stages of crop growth in the treatment T2 (Weed free). Among the other weed control treatments, the lowest weed population (No.) m-2 (14.33, 15.67, 16.33 and 17.67) were observed under the treatments T6 (Pendimethalin PE @ 750g ha-1 *fb* one hand weeding at 25 DAS), T10 (Oxyfluorfen PE @ 100 g ha-1 *fb* one hand weeding at 25 DAS), T3 (One hand weeding at 25 DAS) and T4 (Two hand weeding at 25 and 45 DAS) respectively at 30 DAS. Whereas at 60, 90 DAS and at harvest treatment T4 (Two hand weeding at 25 and 45 DAS), recorded minimum number of weeds (9.00, 14.33 and 15.67) respectively as compared to rest of the treatment. This similar finding was also reported by Malik *et al*. (2005) [7] and Patel *et al*. (2006) [8]. The data on dry weight of weeds (g) m-2 was clearly indicated that the lowest dry weight of weeds (g) m-2 (1.45, 1.86, 2.19 and 3.48) were recorded at 30, 60, 90 DAS and at harvest under treatment T2 (Weed free). Among the rest of other treatments, the minimum dry weight of weeds (g) m-2 were reported with the treatments T6 (Pendimethalin PE @ 750g ha-1 *fb* one hand weeding at 25 DAS) at 30 DAS. At 60, 90 DAS and at harvest treatment T4 (Two hand weeding at 25 and 45 DAS), recorded minimum dry weight of weeds (g) m-2 (4.59, 4.90 and 5.18) respectively. While the highest dry weight of weeds (g) m-2 (25.87, 34.91, 36.43 and 35.91) were found at 30, 60, 90 DAS and at harvest under the treatment T1 (Control). Similar result had also been found by Singh and Singh (2000) [11], Malik *et al*. (2005) [7]. The data pertaining to weed control efficiency (%) was revealed that maximum weed control efficiency (%) (94.37, 94.67, 93.99 and 90.30) were observed at 30, 60, 90 DAS and at harvest under the treatment T2 (Weed free). Among the other treatments, the highest weed control efficiency (%) (83.51, 83.83, 84.38 and 83.81) were noted with the treatments T6 (Pendimethalin PE @ 750g ha-1 *fb* one hand weeding at 25 DAS) at 30 DAS At 60, 90 DAS and at harvest treatment T4 (Two hand weeding at 25 and 45 DAS), recorded the maximum weed control efficiency (%) (86.83, 86.54 and 85.54) respectively. On the other hand, the minimum weed control efficiency (%) (0.00, 0.00, 0.00 and 0.00) were found at 30, 60, 90 DAS and at harvest under the treatment T1 (Control).Similar result had also been found by Patel *et al*. (2006) [8] and Buttar *et al*. (2008) [5]. The data revealed that the plant height increased significantly with integrated weed management.

The maximum plant height (12.12, 27.74, 48.11 and 55.49 cm) was recorded in treatment T2 (Weed free) which was followed by treatment T4 (Two hand weeding at 25 and 45 DAS) and T6 (Pendimethalin @ 750g ha-1 *fb* one hand weeding at 25 DAS). The favourable response of integrated weed management on highest plant height was also delineated by Aslam *et al*. (2007) [2] and Singh *et al*. (2008). The result of the present study indicates that the number of branches and dry weight plant-1 (g) was significantly enhanced with integrated weed management. The highest number of branches (9.95, 12.12, 23.74 and 27.61) and dry weight plant-1 (g) (2.08, 15.92, 26.72 and 35.16) was obtained in in treatment T2 (Weed free) which was followed by treatment T4 (Two hand weeding at 25 and 45 DAS) and T6 (Pendimethalin @ 750g ha-1 *fb* one hand weeding at 25 DAS). A similar result on number of branches and dry weight plant-1 (g) was also found by Patel *et al*. (2006) [8] and Singh *et al*. (2008). Seed yield (q ha-1) of chickpea varied significantly among various weed management treatments. Treatment T2 was significantly enhance the seed yield and commodity value of chickpea. The maximum seed yield (19.59 q ha-1) was obtained under the treatment T2 (Weed free). This similar finding was also reported by Chaudhary *et al*. (2005) [6] and Pooniya *et al*. (2009).

Table 1: Influence of integrated weed management on total weed population (No.) m-2 of chickpea

Treatments		Total weed population (No.) m-2		
30 DAS		**60 DAS**	**90 DAS**	**At harvest**
T1. Weedy check (Control)	90.33	107.67	130.67	133.67
T2. Weed free	6.33	7.00	9.67	7.67
T3. One hand weeding at 25 DAS	16.33	61.33	73.67	89.67
T4. Two hand weeding at 25 and 45 DAS	17.67	9.00	14.33	15.67
T5. Pendimethalin PE @ 750g ha-1	35.67	41.33	49.33	54.67
T6. Pendimethalin PE @ 750g ha-1 *fb* one hand weeding at 25 DAS	14.33	15.67	18.33	24.67
T7. Quizalofop-p-ethyl PoE @40g ha-1	56.67	59.67	66.00	81.00
T8. Quizalofop-p-ethyl PoE @40g ha-1 *fb* one hand weeding at 45 DAS	59.00	36.33	39.67	51.33
T9. Oxyfluorfen PE @ 100 g ha-1	37.67	45.33	51.67	59.33
T10. Oxyfluorfen PE @ 100 g ha-1 *fb* one hand weeding at 25 DAS	15.67	16.67	22.67	29.33
SEm±	1.19	1.33	1.06	0.89
CD(0.05)	3.55	3.99	3.18	2.68

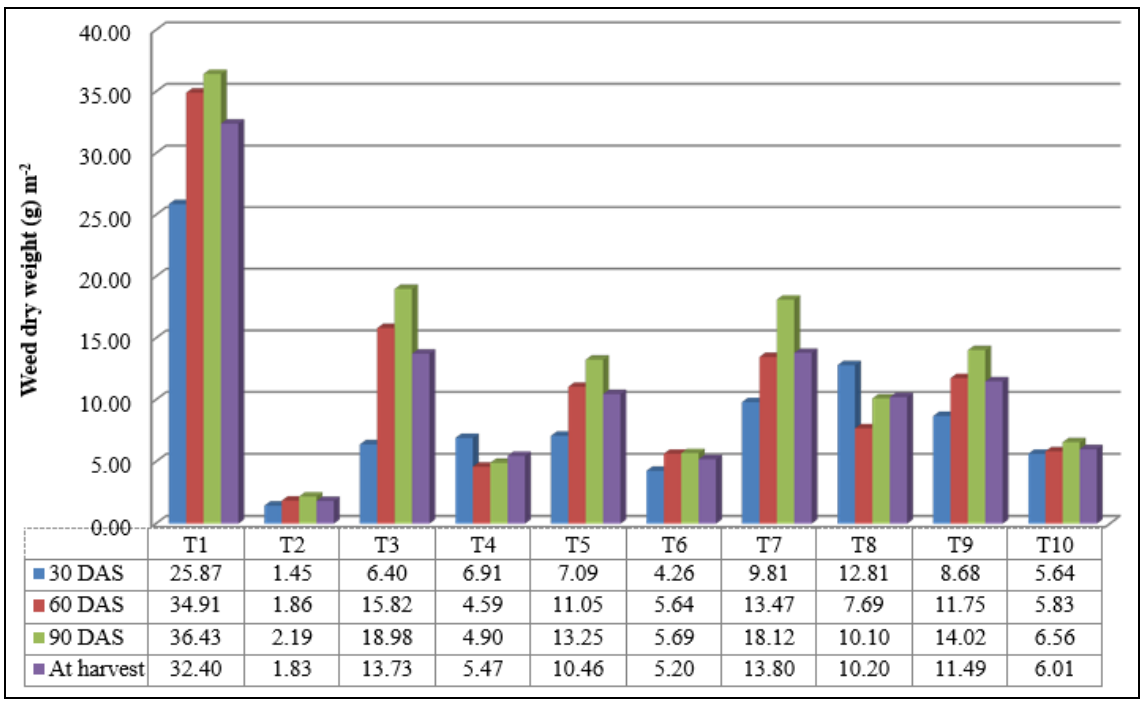


	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
30 DAS	90.33	6.33	16.33	17.67	35.67	14.33	56.67	59.00	37.67	15.67
60 DAS	107.67	7.00	61.33	9.00	41.33	15.67	59.67	36.33	45.33	16.67
90 DAS	130.67	9.67	73.67	14.33	49.33	18.33	66.00	39.67	51.67	22.67
At harvest	109.56	7.67	50.44	13.67	42.11	16.11	60.78	45.00	44.89	18.33

Fig 1: Influence of integrated weed management on total weed population (No.) m-2 of chickpea

Table 2: Influence of integrated weed management on dry weight of weeds (g) m-2 in chickpea

Treatments		Dry weight of weeds (g) m-2		
30 DAS		60 DAS	90 DAS	At harvest
T1. Weedy check (Control)	25.87	34.91	36.43	35.91
T2. Weed free	1.45	1.86	2.19	3.48
T3. One hand weeding at 25 DAS	6.40	15.82	18.98	21.93
T4. Two hand weeding at 25 and 45 DAS	6.91	4.59	4.90	5.18
T5. Pendimethalin PE @ 750g ha-1	7.09	11.05	13.25	13.40
T6. Pendimethalin PE @ 750g ha-1 *fb* one hand weeding at 25 DAS	4.26	5.64	5.69	5.82
T7. Quizalofop-p-ethyl PoE @40g ha-1	9.81	13.47	18.12	20.68
T8. Quizalofop-p-ethyl PoE @40g ha-1 *fb* one hand weeding at 45 DAS	12.81	7.69	10.10	11.73
T9. Oxyfluorfen PE @ 100 g ha-1	8.68	11.75	14.02	13.44
T10. Oxyfluorfen PE @ 100 g ha-1 *fb* one hand weeding at 25 DAS	5.97	5.83	6.56	6.58
SEm±	0.32	0.37	0.30	0.28
CD(0.05)	0.97	1.11	0.91	0.85

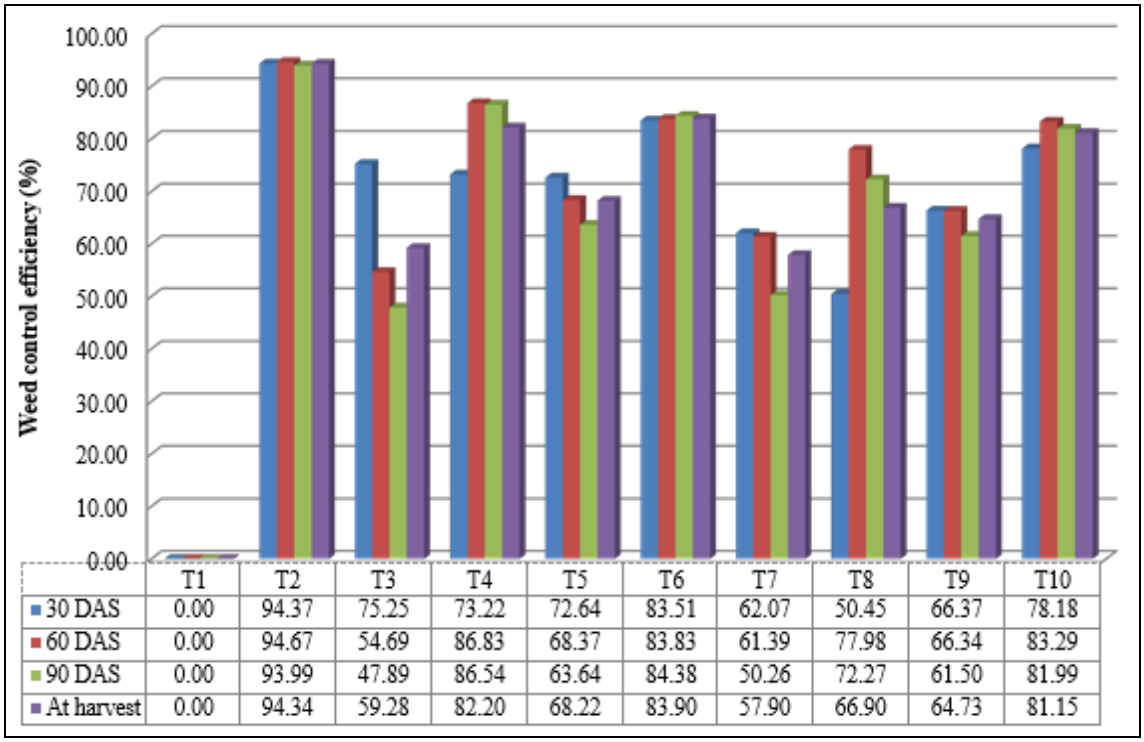


	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
30 DAS	25.87	1.45	6.40	6.91	7.09	4.26	9.81	12.81	8.68	5.64
60 DAS	34.91	1.86	15.82	4.59	11.05	5.64	13.47	7.69	11.75	5.83
90 DAS	36.43	2.19	18.98	4.90	13.25	5.69	18.12	10.10	14.02	6.56
At harvest	32.40	1.83	13.73	5.47	10.46	5.20	13.80	10.20	11.49	6.01

Fig 2: Influence of integrated weed management on dry weight of weeds (g) m-2 in chickpea

Table 3: Influence of integrated weed management on weed control efficiency (%) in chickpea

Treatments		Weed control efficiency (%)		
30 DAS		**60 DAS**	**90 DAS**	**At harvest**
T1. Weedy check (Control)	0.00	0.00	0.00	0.00
T2. Weed free	94.37	94.67	93.99	90.30
T3. One hand weeding at 25 DAS	75.25	54.69	47.89	38.92
T4. Two hand weeding at 25 and 45 DAS	73.22	86.83	86.54	85.54
T5. Pendimethalin PE @ 750g ha-1	72.64	68.37	63.64	62.66
T6. Pendimethalin PE @ 750g ha-1 *fb* one hand weeding at 25 DAS	83.51	83.83	84.38	83.81
T7. Quizalofop-p-ethyl PoE @40g ha-1	62.07	61.39	50.26	42.40
T8. Quizalofop-p-ethyl PoE @40g ha-1 *fb* one hand weeding at 45 DAS	50.45	77.98	72.27	67.31
T9. Oxyfluorfen PE @ 100 g ha-1	66.37	66.34	61.50	62.58
T10. Oxyfluorfen PE @ 100 g ha-1 *fb* one hand weeding at 25 DAS	78.18	83.29	81.99	81.65
SEm±	1.17	1.06	0.86	0.68
CD(0.05)	3.53	3.17	2.58	2.05



	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
30 DAS	0.00	94.37	75.25	73.22	72.64	83.51	62.07	50.45	66.37	78.18
60 DAS	0.00	94.67	54.69	86.83	68.37	83.83	61.39	77.98	66.34	83.29
90 DAS	0.00	93.99	47.89	86.54	63.64	84.38	50.26	72.27	61.50	81.99
At harvest	0.00	94.34	59.28	82.20	68.22	83.90	57.90	66.90	64.73	81.15

Fig 3: Influence of integrated weed management on weed control efficiency (%) in chickpea

Table 4: Influence of integrated weed management on plant height (cm) of chickpea

Treatments		Plant height (cm)		
30 DAS		**60 DAS**	**90 DAS**	**At harvest**
T1. Weedy check (Control)	6.18	18.94	31.55	36.64
T2. Weed free	12.12	27.74	48.11	55.49
T3. One hand weeding at 25 DAS	10.51	21.97	42.03	49.53
T4. Two hand weeding at 25 and 45 DAS	10.69	24.96	46.25	54.79
T5. Pendimethalin PE @ 750g ha-1	9.67	22.91	45.11	51.82
T6. Pendimethalin PE @ 750g ha-1 *fb* one hand weeding at 25 DAS	12.01	23.87	45.77	53.06
T7. Quizalofop-p-ethyl PoE @40g ha-1	9.01	21.99	43.27	49.55
T8. Quizalofop-p-ethyl PoE @40g ha-1 *fb* one hand weeding at 45 DAS	8.86	23.28	44.67	51.88
T9. Oxyfluorfen PE @ 100 g ha-1	9.54	22.64	43.66	50.17
T10. Oxyfluorfen PE @ 100 g ha-1 *fb* one hand weeding at 25 DAS	11.76	23.34	45.04	52.48
SEm±	0.32	0.86	0.84	0.60
CD(0.05)	0.96	2.60	2.53	1.78

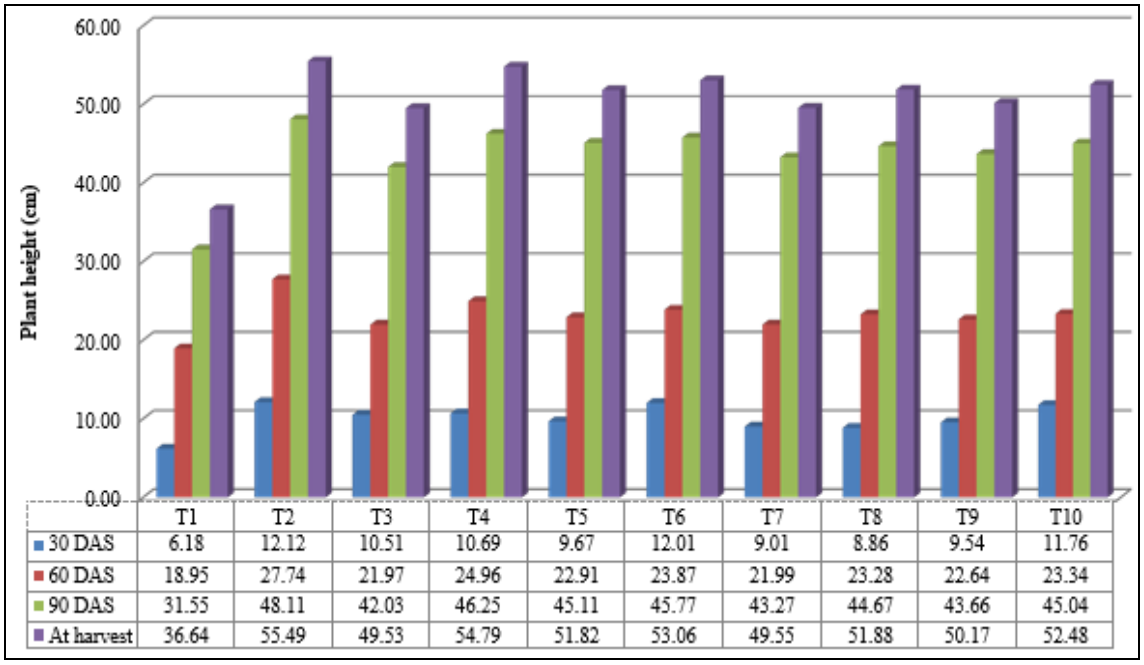


Fig 4: Influence of integrated weed management on plant height (cm) of chickpea

Table 5: Influence of integrated weed management on number of branches plant-1 of chickpea

Treatments		Number of branches plant-1		
30 DAS		60 DAS	90 DAS	At harvest
T1. Weedy check (Control)	5.99	9.12	15.61	18.16
T2. Weed free	9.95	16.91	23.74	27.61
T3. One hand weeding at 25 DAS	9.18	12.94	17.91	21.67
T4. Two hand weeding at 25 and 45 DAS	9.10	16.43	23.48	27.41
T5. Pendimethalin PE @ 750g ha-1	9.04	15.20	19.41	23.00
T6. Pendimethalin PE @ 750g ha-1 *fb* one hand weeding at 25 DAS	9.74	16.21	22.27	26.74
T7. Quizalofop-p-ethyl PoE @40g ha-1	8.78	13.17	18.86	22.74
T8. Quizalofop-p-ethyl PoE @40g ha-1 *fb* one hand weeding at 45 DAS	8.67	15.32	21.26	25.59
T9. Oxyfluorfen PE @ 100 g ha-1	8.83	13.34	19.28	22.94
T10. Oxyfluorfen PE @ 100 g ha-1 *fb* one hand weeding at 25 DAS	9.52	15.79	21.85	25.96
SEm±	0.25	0.31	0.38	0.40
CD(0.05)	0.75	0.94	1.14	1.20

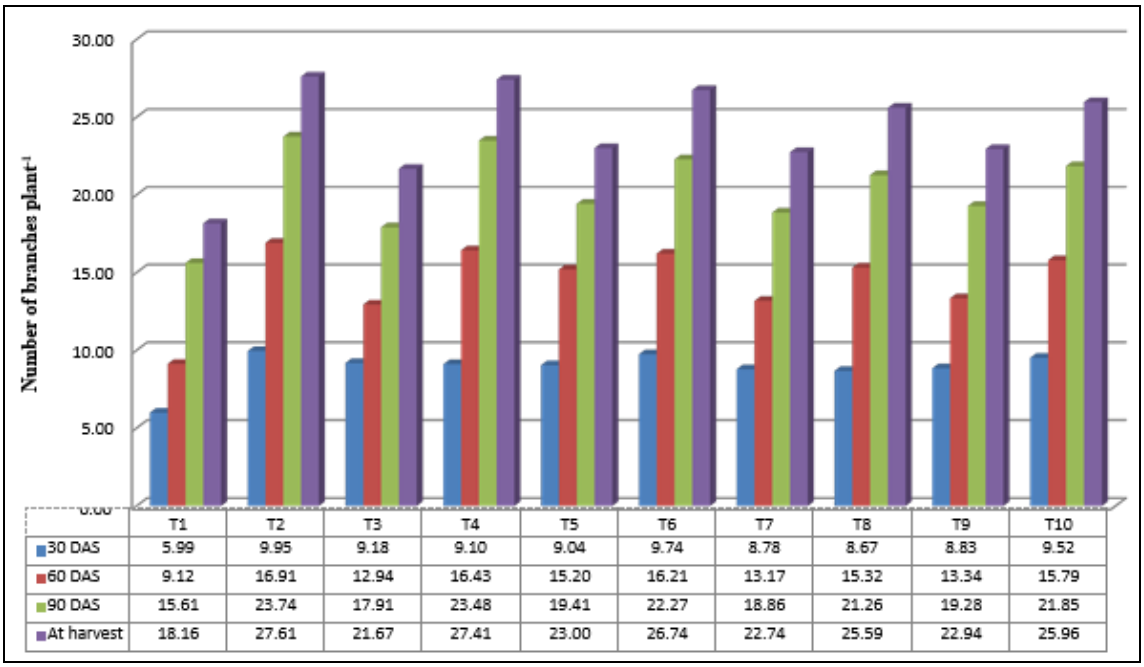


Fig 5: Influence of integrated weed management on number of branches plant-1 of chickpea

Table 6: Influence of integrated weed management on dry weight (g) plant-1 of chickpea

Treatments		Dry weight (g) plant-1		
30 DAS		60 DAS	90 DAS	At harvest
T1. Weedy check (Control)	1.23	12.15	17.57	23.13
T2. Weed free	2.08	15.92	26.72	35.16
T3. One hand weeding at 25 DAS	1.46	12.44	22.48	29.81
T4. Two hand weeding at 25 and 45 DAS	1.45	14.85	25.90	34.05
T5. Pendimethalin PE @ 750g ha-1	1.38	13.63	23.72	32.43
T6. Pendimethalin PE @ 750g ha-1 *fb* one hand weeding at 25 DAS	1.78	14.38	25.68	33.27
T7. Quizalofop-p-ethyl PoE @40g ha-1	1.34	12.77	22.89	30.35
T8. Quizalofop-p-ethyl PoE @40g ha-1 *fb* one hand weeding at 45 DAS	1.32	13.88	23.86	33.20
T9. Oxyfluorfen PE @ 100 g ha-1	1.37	13.45	23.58	30.77
T10. Oxyfluorfen PE @ 100 g ha-1 *fb* one hand weeding at 25 DAS	1.75	14.28	25.09	32.60
SEm±	0.11	0.52	0.40	0.39
CD(0.05)	0.34	1.56	1.19	1.18

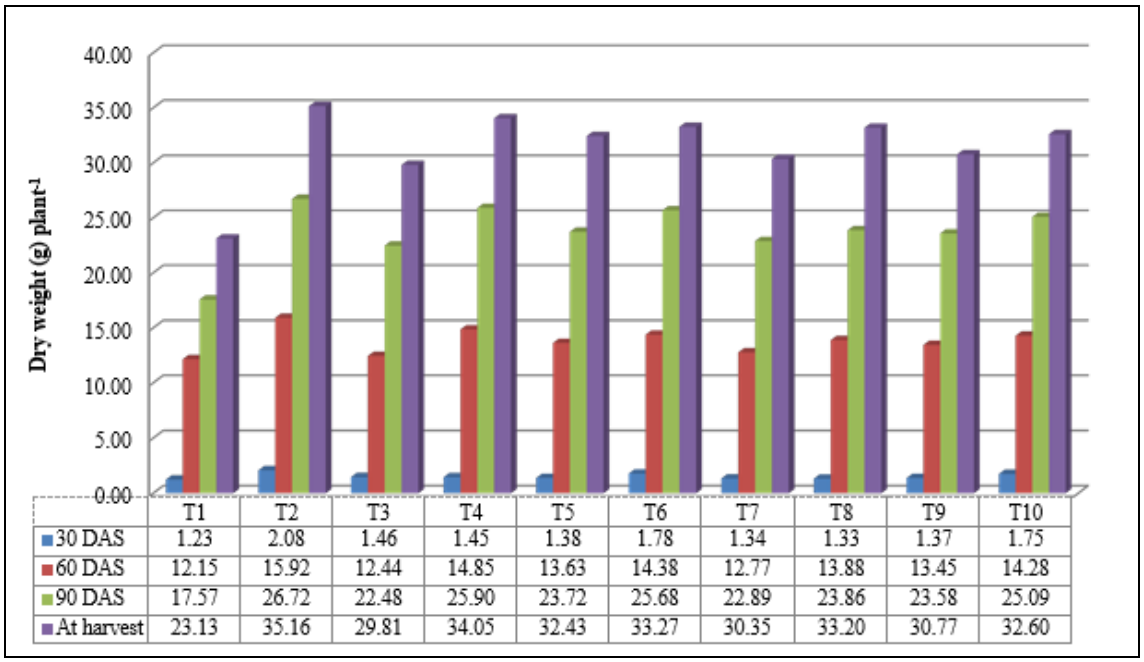


Fig 6: Influence of integrated weed management on dry weight (g) plant-1 of chickpea

Table 7: Influence of integrated weed management on seed yield (q ha-1)

Treatments	Seed yield
T1. Weedy check (Control)	11.23
T2. Weed free	19.59
T3. One hand weeding at 25 DAS	13.23
T4. Two hand weeding at 25 and 45 DAS	17.99
T5. Pendimethalin PE @ 750g ha-1	13.67
T6. Pendimethalin PE @ 750g ha-1 *fb* one hand weeding at 25 DAS	17.33
T7. Quizalofop-p-ethyl PoE @40g ha-1	13.26
T8. Quizalofop-p-ethyl PoE @40g ha-1 *fb* one hand weeding at 45 DAS	14.97
T9. Oxyfluorfen PE @ 100 g ha-1	13.66
T10. Oxyfluorfen PE @ 100 g ha-1 *fb* one hand weeding at 25 DAS	16.63
SEm±	0.28
CD(0.05)	0.85

Conclusion

On the basis of the results from the present investigation, the following conclusion has been drawn:

a) Two hand weeding at 25 and 45 DAS was found most effective in minimizing the weed population and having maximum weed control efficiency. Among the other integrated treatments, Pendimethalin PE @ 750g ha-1 *fb* one hand weeding at 25 DAS found to be superior over the rest of treatments.

b) Application of pendimethalin PE @ 750g ha-1 *fb* one hand weeding at 25 DAS was found similar to treatment Two hand weeding at 25 and 45 DAS in improving the plant growth and yield indices, i.e., number of pods plant-1, number of seeds pod-1. Seed and straw yields were highest under two hand weeding at 25 and 45 DAS followed by treatment pendimethalin PE @ 750g ha-1 *fb* one hand weeding at 25 DAS.

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