RESEARCH ARTICLE

EFFECT OF DIFFERENT TILLAGE AND WEED MANAGEMENT PRACTICES ON GROWTH AND YIELD OF CHICKPEA (*CICER ARIETINUM* L.)

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Abstract: The field experiment was conducted at the JNKVV, Jabalpur (M.P.) during rabi seasons of 2013-14 and 2014-15 to study the different tillage and weed management methods on growth product and yield of chickpea. The experiment was laid out in split-plot design with three replications. Main plot treatment consisted of five tillage practices viz., T_1- Zero tillage, T_2- Reduced tillage, T_3- Conventional tillage, T_4-Broadcasting and T_5-Bed planting. There were four sub-plot treatments of weed management viz., W_1-Pendimethalin PE @ 1 kg ai./ha, W_2-Pendimethalin + Imazethapyr (Vellor) @ 1 kg ai./ha PE, W3- Oxyfluorfen @ 100 gai./ha PE, and W_4-Unweeded check. Chickpea var. JG14 was shown on 15 December in both the years in rows 30 cm. apart keeping a seed rate of 80 Kg./ha Amongst the tillage practices, conventional tillage and bed planting recorded maximum growth and yield attributes and grain yield of chickpea var. JG – 14 (12.03 to 13.02 q/ha). Amongst the herbicidal treatments, Pendimethalin + imazethapyr were found most effective in controlling existing weed- flora and recorded maximum growth, yield attributes and grain yield upto 13.09 q/ha.

Keywords: Chickpea, Growth, Management, Tillage, Weed

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is the major *rabi* pulse crop next to pigeonpea and soybean in India. Chickpea was grown over an area of 7.37 mha with a production of 5.89 mt in M.P. chickpea was cultivated over an area of 6.81 lakh ha with a production of 4.85 lakh t (Anon, 2013a). Pulses play an important role in Indian diet due to preferences of the majority people for vegetarian diet. Shortage of pulses in the country resulted in malnutrition of the vulnerable sections of our society. Nutritionists consider supplementation of pulses with cereal based diets was one of the best possible options to mitigate the problems associated with protein malnutrition. Indian Council of Medical Research (ICMR) recommended 50 g per capita per day pulses to meet the protein requirement of the body. Whereas, the present per capita availability of pulses in India is less than 30g. To bridge the gap pulse production has to be increased from the present 14.76 mt to 28 mt by 2020 which is a herculean task. One of the options to increase production is to increase the area under pulses which is not possible as these crops can not compete with other profitable cereals, oilseeds or multiple cropping/ sequence cropping systems.

The zero tillage technology has been developed with the objective to reduce the turn around time and establish good crop without loss in yield. Moreover zero tillage may advance the sowing of chickpea and consequently improve the grain yield as compared to conventional tillage system. Conventional method of sowing by giving repeated tillage delays the sowing and significantly reduces the yield (Kumar et al., 2005).In India, weed management accounts for 30-50% share of the total cost of cultivation (Bhan 1997). Costs on weed control are the largest variable costs in most crop cultivation. Usage of pre-emergence herbicide assumes greater importance in the view of their effectiveness from initial stages. As the weeds interfere during the harvesting of crops, post emergence herbicides at about 40-45 days after sowing (DAS) may help in avoiding the problem of weeds at later stages. Under this situation, managing weeds through pre-emergence and post emergence herbicides will be an ideal means of controlling weeds.

MATERIALS AND METHODS

The field experiment was conducted at the JNKVV, Jabalpur (M.P.) during rabi seasons of 2013-14 and 2014-15 to study the tillage and weed management methods on growth and productivity of chickpea. The experiment was laid out in split-plot design with three replications. Main plot treatment consisted of five tillage practices viz., T_1- Zero tillage, T_2- Reduced tillage, T_3- Conventional tillage, T_4- Broadcasting and T_5-Bed planting. There were four sub-plot treatments of weed management viz., W_1-Pendimethalin PE @ 1 kgai./ha, W_2-Pendimethalin + Imazethapyr (Vellor) @ 1 kg ai./ha PE, W_3-Oxyfluorfen @ 100 gai./ha PE, and W4-Unweeded check. Chickpea var. JG14 was shown on 15 December in both the years with 30 cm rows spacing, apart keeping a seed rate of 80 Kg/ha.

RESULTS AND DISCUSSION

Plant population/m^2

The data presented in (Table 1) reveal that the plant population/m^2 of chickpea did not change due to

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various treatments at 20 DAS stage in both the years. It ranged from 48.50 to 48.67/m^2 in stage first year and 55.42 to 55.67/m^2 in second year. But at harvest stage the plant population changed significantly in both the years. It ranged from to 34.83 to 39.74/m^2 in first year and 24.73 to 31.88 in second year. The plant population was found equally significantly higher (39.38/m^2 in first year and 31.88/m^2 in second year in case of conventional tillage and bed planting system. It was lower in case of broadcasting followed by reduced tillage treatment. Similarly the plant population was found significantly higher under herbicidal treatments applied or singly. It ranged from 38.17 to 39.40/m^2 in first year and 32.30 to 33.00/m^2 second year. The control treatment recorded significantly lowest plant population (34.83/m^2 in first year and 24.73/m^2 in second year). The best treatment interaction was conventional tillage and bed planting applied with pendimethalin + imazethapyr the plant population was (41.33 to 41.73/m^2 in first year and 34.00 to 34.07/m^2 in second year). The lowest plant population was (34.50/m^2 in first year and 24.70/m^2 in second year) in case of zero tillage without application of herbicides.

Table 1. Plant population/m^2 of chickpea as affected by different tillage practices and herbicides

Treatment	Plant population($m^{2)}$ at 2013-14		2014-15	
	20 DAS	At Harvest	20 DAS	Harvest
Tillage practice				
Zero tillage	53.33	36.71	52.58	30.43
Reduced tillage	52.92	37.38	52.42	30.88
Conventional tillage	55.67	39.74	55.42	31.58
Broadcasting followed by reduced tillage	51.08	35.43	51.33	28.93
Bed planting	48.67	39.38	48.50	31.88
SEM ±	0.83	0.88	0.87	0.57
C.D. (5%)	2.72	2.88	2.84	1.86
Herbicides				
Pendimethalin (1 kg/ha)	52.27	38.17	51.73	32.30
Pendimethalin + Imazethapyr (1 kg/ha)	53.07	39.40	53.07	33.00
Oxyfluorfen (100g/ha)	50.93	38.52	50.80	32.92
Control	53.07	34.83	52.60	24.73
SEm+_	1.16	0.69	1.03	0.37
LSD(P=0.05)	NS	NS	2.99	1.08

Plant height

The quantitative observations (Table 2) revealed that the plant height increased progressively (nearly three fold) up to 90 DAS and slight increase up to harvest irrespective of the treatments effect. At 30 DAS, it ranged from 18.79 to 20.46 cm and at harvest stage, 56.11 to 61.38 cm in various treatments. Different treatments exerted significant impact up on plant height at all the stages of observations in both the years. Amongst the tillage practices, conventional tillalge produced almost significantly tallest plants (20.10 at 30 DAS to 61.38 cm at harvest) as compared to broadcasting followed by reduced tillageing only (18.79 cm at 30 DAS to 58.67 cm at harvest). The remaining three tillage practices resulted in equal performance with that of conventional tillage where the plant height values were in the intermediate range at every stage in both the years. As regards with the herbicidal treatments, pendimethlin + imazethapyr resulted in significantly tallest plants (20.46 cm at 30 DAS to 61.37 cm at harvest) as compared to un weeded control only. (18.85 cm at 30 DAS to 56.11 cm at harvest). That means the performance of pendimethlin + imazethapyr, pendimethalin and oxyfluorfen applied alone was statistically at par. The plant height values in case of pendimethalin and oxyfluorfen were in the intermediate range throughout the observation period.

Table 2. Plant height (cm) of chickpea as affected by different tillage practices and herbicides

Treatments	Successive growth stages (DAS)											
	30			60			90			Harvesting		
	2013-14	2014-15	Mean	2013-14	2014-15	Mean	2013-14	2014-15	Mean	2013-14	2014-15	Mean
Tillage practice												
Zero tillage	19.24	19.24	19.26	34.43	34.41	34.42	54.33	54.50	54.42	59.04	58.87	58.96

Reduced tillage	19.18	19.26	19.22	35.48	35.31	35.39	54.83	54.79	54.81	59.58	59.33	59.45
Conventional tillage	20.08	20.08	20.10	36.18	37.28	36.73	56.67	56.83	56.75	61.79	60.96	61.38
Broadcasting followed by reduced tillage	18.69	18.86	18.79	33.43	33.27	33.35	53.17	53.25	53.21	58.79	58.54	58.67
Bed planting	19.27	19.35	19.31	35.43	35.68	35.56	55.92	56.08	56.00	60.79	60.38	60.58
SEm ±	**0.24**	**0.24**	**0.24**	**0.52**	**0.46**	**0.40**	**0.69**	**0.55**	**0.61**	**0.56**	**0.52**	**0.53**
CD at 5%	**0.78**	**0.77**	**0.79**	**1.69**	**1.48**	**1.31**	**2.24**	**1.80**	**1.99**	**1.83**	**1.68**	**1.72**
Herbicide												
Pendimethalin (1 kg/ha)	18.91	19.04	18.98	34.44	35.12	34.78	54.53	55.17	54.85	60.61	60.21	60.41
Pendimethalin + Imazethapyr (1 kg/ha)	20.43	20.50	20.46	36.22	36.22	36.22	57.47	56.73	57.10	61.67	61.07	61.37
Oxyfluorfen (100g/ha)	18.99	19.05	19.05	35.44	35.55	35.50	55.80	55.87	55.83	61.10	60.57	60.83
Control	18.84	18.84	18.85	33.85	33.85	33.85	52.13	52.60	52.37	56.61	55.61	56.11
SEm ±	**0.26**	**0.22**	**0.24**	**0.27**	**0.49**	**0.34**	**0.51**	**0.51**	**0.48**	**0.62**	**0.54**	**0.57**
CD at 5%	**0.74**	**0.65**	**0.68**	**.79**	**1.40**	**0.98**	**1.48**	**1.47**	**1.39**	**1.78**	**1.55**	**1.65**

Number of branches /plant

The periodical observations on the formation of number of branches/plant (Table 3) indicated that this parameter was enhanced by multifold upto 60 DAS, thereafter the increment was slow upto 90 DAS stage of observations. This was found irrespective of the treatments effect. At 30 DAS, the branches formation ranged from 2.70 to 3.51/plant and at 90 DAS stage, 21.15 to 25.19/plant under various treatments. Tillage practices and herbicides application brought about significant influence up on branches formation at every stage of observations both the years. Out of different tillage practices, zero, reduced and conventional tillage resulted in equally higher number of branches/plant which was almost significantly superior to Broadcasting followed by reduced tillage. This was the situation at every growth stage in both the years. Accordingly at 90 DAS, the branches ranged from 23.44 to 24.59/plant, being significantly superior to Broadcasting followed by reduced tillage (22.60/plant) based on two years mean values. Amongst the herbicidal treatments, all the three herbicides (pendimethalin, pendimethlin + imazethapyr and oxyfluorfen) were found equally most effective in the formation of higher number of branches/plant and proved significantly superior to un weeded control. Accordingly at 90 DAS, the higher branches ranged from 23.97 to 25.19/plant as against the significantly lowest (21.15/plant) in case of UN weeded control.

Table 3. Number of branches/ plant of chickpea as affected tillage practices and herbicides

Treatments	**Successive growth stages (DAS)**								
	30			**60**			**90**		
	2013-14	**2014-15**	**Mean**	**2013-14**	**2014-15**	**Mean**	**2013-14**	**2014-15**	**Mean**
Tillage practice									
Zero tillage	3.08	3.00	3.04	19.00	19.02	19.01	22.75	22.92	22.83
Reduced tillage	3.17	3.13	3.15	19.25	19.5	19.38	23.23	24.07	23.65
Conventional tillage	3.47	3.55	3.51	20.36	20.44	20.40	24.44	24.53	24.48
Broadcasting followed by reduced tillage	2.67	2.73	2.70	18.08	18.33	18.21	22.85	22.35	22.60
Bed planting	3.23	3.33	3.28	20.37	20.62	20.49	24.47	24.72	24.59
SEm ±	0.22	0.21	0.21	0.48	0.42	0.45	0.31	0.52	0.36
CD at 5%	0.72	0.68	0.70	1.58	1.35	1.45	1.02	1.68	1.18
Herbicide									
Pendimethalin (1 kg/ha)	3.16	3.13	3.15	20.14	20.46	20.30	24.30	23.63	23.97
Pendimethalin + Imazethapyr (1 kg/ha)	3.32	3.39	3.35	21.23	21.39	21.31	24.76	25.63	25.19
Oxyfluorfen (100g/ha)	3.31	3.37	3.34	20.53	20.73	20.63	24.12	24.32	24.22

Control	2.71	2.71	2.71	15.75	15.75	15.75	21.01	21.28	21.15
SEm ±	0.11	0.11	0.11	0.32	0.37	0.37	0.57	0.51	0.49
CD at 5%	0.32	0.32	0.31	0.38	1.06	1.07	1.64	1.48	1.41

Yield- attributes

Number of pods/plant

The seriating of data in Table 4. revealed that different tillage practices and herbicides exerted significant influence upon this parameter in both the years. The treatment interactions were also found to be significant. Bed planting recording significantly higher number of pods (26.06/plant) as compared to remaining tillage practices except conventional tillage (25.88 pods/plant). This was followed by zero and reduced tillage. The significantly lowest number of pods (22.94/plant) was recorded from Broadcasting followed by reduced tillage. All the three herbicides were found equally effective in producing higher number of pods (27.06 to 28.20/plant). The unweeded control resulted in significantly lowest pod number (16.40/plant).

Number of seeds/pod

The data pertaining to number of seeds/pod are presented in Table 4. This parameter was not influenced significantly due to different tillage practices in both the years. However bed planting recorded maximum seeds (1.45/pod) and broadcasting followed by reduced tillage showed minimum seeds (1.45/pod). The herbicide pendimethlin + imazethapyr resulted in significantly higher seeds count (1.46/pod) over unweeded control only (1.46/pod). Pendimethalin and oxyfluorfen recorded equal values (1.49 to 1.51 seeds/pod).

Seed index

The data related to seed index (100 seed weight) are highlighted in Table 4. The tillage practices as well as different herbicides brought about significant influence upon seed index in both the years. Based on two years mean data zero, reduced and conventional tillage and bed planting recorded equally higher seed index (26.42 to 26.88 g) and proved significantly superior to broadcasting followed by reduced tillage (25.60 g). This trend was noted in both the years. Similarly all the three herbicides (pendimethalin, pendimethlin + imazethapyr and oxyfluorfen) proved equally most effective in increasing this parameter (26.65 to 27.73 g). Whereas unweeded control recorded significantly lowest seed index (24.23 g) based on two years mean values.

Table 4. Yield attributes of chickpea as affected by different tillage practices and herbicides

Treatments	**Yield attributes**								
	Pods / plant			**Seeds / pod**			**Seed index**		
	2013-14	**2014-15**	**Mean**	**2013-14**	**2014-15**	**Mean**	**2013-14**	**2014-15**	**Mean**
Tillage practice									
Zero tillage	24.3	24.31	24.14	1.56	1.56	1.56	26.33	26.50	26.42
Reduced tillage	24.7	24.74	24.53	1.50	1.50	1.50	26.50	26.75	26.63
Conventional tillage	25.9	26.21	25.88	1.49	1.53	1.51	26.58	26.83	26.70
Broadcasting followed by reduced tillage	23.0	23.36	22.94	1.42	1.48	1.45	25.48	25.73	25.60
Bed planting	26.0	26.41	26.06	1.59	1.63	1.61	26.76	27.01	26.88
SEm ±	0.44	0.35	0.40	0.10	0.08	0.09	0.23	0.28	0.24
CD at 5%	1.42	1.15	1.31	NS	NS	NS	0.75	0.93	0.79
Herbicide									
Pendimethalin (1 kg/ha)	27.10	27.36	27.06	1.49	1.49	1.49	26.49	26.82	26.65
Pendimethalin + Imazethapyr (1 kg/ha)	28.27	28.60	28.20	1.63	1.65	1.64	27.63	27.83	27.73
Oxyfluorfen (100g/ha)	27.20	27.49	27.18	1.50	1.53	1.51	27.03	27.30	27.17
Control	16.57	16.57	16.40	1.43	1.49	1.46	24.16	24.29	24.23
SEm ±	0.39	0.39	0.39	0.06	0.05	0.05	0.35	0.31	0.32
CD at 5%	1.14	1.13	1.14	0.18	0.15	0.16	1.02	0.88	0.94

Grain yield

The grain yield q./ha of different treatment combinations was calculated from the grain yield obtained in kg/plot. The data after statistical analysis are presented in Table 5 for both the years. Different treatments influenced this parameter significantly. Bed planting produced significantly highest grain (13.02 q/ha) as compared to the remaining tillage practices. However, the second best was conventional tillage (12.03 q/ha). Zero and reduced tillage performed equally better (10.15 to 10.41 q/ha). The significantly lowest yield (9.34 q/ha) was secured from the broadcasting followed by reduced tillagemethod of sowing. These are based on two years mean values.

In case of herbicidal treatments, pendimethlin + imazethapyr recorded significantly higher grain yield (13.09 q/ha) as compared to the remaining herbicides

treatments. Pendimethalin and oxyfluorfen resulted in equal performance, the yield being 12.05 to 12.21 q/ha. The significantly lowest grain yield (6.60 q/ha) was obtained from the un weeded control.

Straw yield

The straw yield in q/ha of different treatment combinations was also calculated from the straw yield obtained in kg/plot. Thus data so obtained were subjected to statistical computation for both the years. The data presented in Table 5 reveal that the different treatments as well as their interactions resulted in significant impact upon the straw productivity in both the years. Conventional tillage as well as bed planting both performed the equally best producing 33.30 to 33.70 q/ha straw based on two years mean values. These straw yields were found significantly superior to the remaining tillage practices. Zero and reduced tillage produced equal straw (29.85 to 30.53 q/ha). Reduced tillage proved significantly superior to broadcasting followed by reduced tillagegiving 30.53 and 28.19 q/ha respective yields.

Amongst the herbicidal treatments, pendimethlin + imazethapyr brought about significantly higher straw yield (35.27 q/ha) as compared to the remaining herbicidal treatments. Pendimethalin and oxyfluorfen resulted in equal performance (32.93 to 33.63 q/ha) in straw production. The significantly lowest straw yield (22.64 q/ha) was obtained from the unweeded control.

Harvest Index (HI)

The perusal of data in Table 1.5 reveal that the HI was influenced significantly due to tillage practices herbicides as well as treatment interactions in both the years. Amongst the tillage practices, bed planting recorded significantly higher HI (27.58%) as compared to all the remaining treatments. However, the second best was conventional tillage (26.21%) equally followed by zero and reduced tillage (25.08 to 25.12 %) broadcasting followed by reduced tillage recorded the lowest HI (24.63%). In case of herbicidal treatments, single as well as pendimethalin + imazethapyr resulted in equally maximum HI (26.55 to 27.08%), being significantly higher to control (22.55%). The best treatment interactions were bed planting with single and herbicide application which resulted in equally maximum HI (28.37 to 29.24 %), being significantly superior to rest of the interactions. Under each of the tillage systems, herbicides applied singly or double, resulted in equal performance. The second best was conventional tillage under each of the herbicidal treatments. The significantly lower HI values (21.64 to 23.72 %) were noted from the control treatment under each of the tillage practices. Broadcasting followed by reduced tillage and reduced tillage with control recorded the minimum HI (21.64 to 21.77%).

Table 5. Yield and harvest index of chickpea as affected by different tillage practices and herbicides Discussion

Treatments	Yield								
	Grain yield			Stover yield			Harvest index		
	2013-14	2014-15	Mean	2013-14	2014-15	Mean	2013-14	2014-15	Mean
Tillage practice									
Zero tillage	9.52	10.77	10.15	28.06	31.56	29.85	25.07	25.17	25.12
Reduced tillage	9.86	10.95	10.41	28.53	32.62	30.53	25.35	24.82	25.08
Conventional tillage	11.13	12.93	12.03	30.22	36.47	33.3	26.48	25.94	26.21
Broadcasting followed by reduced tillage	9.01	9.67	9.34	27.24	29.24	28.19	24.54	24.71	24.63
Bed planting	12.03	14	13.02	29.5	37.91	33.7	28.42	26.74	27.58
SEm ±	0.24	0.23	0.24	0.48	0.48	0.48	0.35	0.34	0.35
CD at 5%	0.78	0.76	0.78	1.58	1.57	1.58	1.15	1.13	1.14
Herbicide									
Pendimethalin (1 kg/ha)	11.16	12.94	12.05	29.73	36.13	32.93	27.17	26.27	26.72
Pendimethalin + Imazethapyr (1 kg/ha)	12.44	13.74	13.09	31.8	38.74	35.27	28.03	26.13	27.08
Oxyfluorfen (100g/ha)	11.3	13.11	12.21	30.66	36.59	33.63	26.82	26.27	26.55
Control	6.34	6.87	6.6	22.64	22.77	22.64	21.86	23.23	22.55
SEm ±	0.14	0.14	0.14	0.30	0.30	0.30	0.29	0.29	0.29
CD at 5%	0.42	0.42	0.42	0.87	0.86	0.87	0.83	0.83	0.83

Growth parameters

Amongst the tillage practices, conventional tillage produced almost significantly tallest plants of chickpea at every growth stage as compared to only broadcasting followed by reduced tillage sowing method. Zero and reduced tillage as well as bed planting resulted in equal performance with that of conventional tillage where the values were in the intermediate range. In case of formation of branches per plant, zero, reduced and conventional tillage were found equally effective and proved significantly superior to Broadcasting followed by reduced tillage

method. As regards with the dry weight per plant, conventional tillage and bed planting brought about equally higher influence. In contrast equally lower dry weight /plant was noted from zero and reduced tillage as well as broadcasting followed by reduced tillage sowing method at every stage of observations.

The overall periodical observations from these growth parameters of chickpea indicate that the conventional tillage and bed planting performed the best whereas broadcasting followed by reduced tillage showed the lowest performance through out the period of observations. The tillage practices, in general, recorded lower number and dry weight of weeds as compared to minimum/ reduced or zero tillage practices. This was due to periodical disturbance of establishment of weeds facilitating increased availability of resources like space, nutrient, light and moisture etc. to attain good growth and consequently yield. Similar results were observed in green gram and in Chickpea.

As regards with the herbicidal treatments, wiz. All the three herbicides pendimethlin, pendimethlin + imazethapyr and oxyfluorfen resulted in equal performance in raising the plant height, formation of branches and dry matter production per plant up to the maximum extent. These herbicides proved significantly superior to unweeded control throughout the period of observations. The action of herbicides (pendimethlin + imazethapyr) as already narrated earlier, have reduced weed population and increased the most favourable conditions like space, light nutrients and moisture which permitted better plant height and formation of branches per plant.

The present findings corroborate with those of many researchers Nigappa, 2013.

Yield- attributing parameters

The factors which are directly responsible for ultimate grain production viz. pods/plant seeds /pod and seed index (100 - grain weight) were augmented almost equally maximum due to conventional tillalge and bed planting practices. Both these practices were significantly superior to zero and reduced tillage as well as Broadcasting followed by reduced tillage sowing. Pods/plant ranged from 25.9 to 26.1, seeds/pod 1.56 to 1.61 and seed index 26.70 to 26.88 g from both these best tillage practices. The higher yield attributes of chickpea from conventional tillage and bed planting may be owing to maximum increase in the growth parameters (plant height and branches/plant) including dry weight/plant, growth analysis parameters. The higher yield may be due to better carbon assimilation, better accumulation of carbohydrates and reduced respiration in plants (Manjunatha, 2007). The present findings are in consonance with those of other research workers Thripathi *et al*. (2004), Nigam (2008) Mukundan et al. (2008), Billore et al. (2009) and Manjith Kumar (2014).

All the three herbicidal treatments (Pendimethalin, Pendimethalin + imazethapyr and oxyfluorfen) resulted in equally significantly higher number of pods (27.1 to 28.2/plant). Seeds formation (1.49 to 1.64/pod) and seed index (26.65 to 27.17 g) as compared to un weeded control. The higher yield attributes from these herbicidal applications may be owing to increased plant growth and growth analysis parameters as a result of least crop weed competition and thereby increased supply of all th essential plant nutrients and other growth resources.

All these favourable conditions might have brought about greater accumulation of carbohydrates, protein (photosynthates) and their translocation to the reproductive organs which, in turn , increased the higher number of pods as well as other yield components. These results pertaining to maximum weed control thereby increased yield attributes due to herbicidal applications are in close agreement with those of many researches (Patel et al. 2006 and Nigam, 2008).

Productivity parameters

Grain yield of chickpea

Bed planting produced significantly highest grain of chickpea (13.02 q/ha) as compared to the remaining tillage practices. However, the second best was conventional tillage (12.03 q/ha) zero and reduced tillage performed equally lower yield (10.15 to 10.41 q/ha). The significantly lowest yield (9.34 q/ha) was secured from the Broadcasting followed by reduced tillage method of sowing. The was owing to increased number of pods per plant, biological yield and increased index (Manjith Kumar, 2014). The increase in harvest index with bed planting and conventional tillage was noticed over minimum and zero tillage practices. The differences in harvest index may be attributed to their differential partitioning of dry matter into reproductive parts (Kalpan, 2000). The higher yield may be attributed to better carbon assimilation, better accumulation of carbohydrates and reduced respiration in plants (Manjunatha, 2007). These results are in conformity with the findings of Thripathi *et al*. , 2004; Mukundam et al. , 2008; Nigam , 2008, Billore et al. , 2009 and Manjith Kumar, 2014).

In case of herbicidal treatments, Pendimethalin + imazethapyr recorded significantly higher grain yield of chickpea (13.09 q/ha) as compared to the remaining herbicides treatments. Pendimethalin and oxyfluorfen resulted in equal performance, the yield being 12.05 to 12.21 q/ha. The significantly lowest grain yield (6.60 q/ha) was obtained from the unweeded control.

The increase in yield under herbicide application was due to minimum crop weed competition throught the crop growth period which is evident from significantly lower weed population and weed dry weight at various stages thus enabled the crop for maximum utilization of nutrients, moisture, light and space which further influenced the growth and yield components. Reduced weed population directly facilitated increased supply of nitrogen

photosynthates and water for sink development (Kumar, 2008). Economic yield is associated with harvest index and total dry matter production per plant. The increased harvest index with application of and single herbicides (Pendimethalin, with and without imazethapyr and oxyfluorfen) was noticed over un weeded check (control). Economic yield is function of yield attributing characters (Seemantim, 2011). Thus application of Pendimethalin + imazethapyr influenced greater accumulation of photosynthates and effective utilization of available resources in turn resulting in higher yield and yield parameters. These results are in agreement with the findings of Tanveer et al. (1999). Singh and Singh (2003) Muhammad et al., (2009) ,Nigam (2008) and Deshmukh et al., (2008).

CONCLUSIONS

Amongst the tillage practices, conventional tillage and bed planting recorded maximum growth and yield attributes and grain yield of chickpea var. JG – 14 (12.03 to 13.02 q/ha). Amongst the herbicidal treatments, pendimethalin + imazethapyr were found most effective in controlling existing weed- flora and recorded maximum growth, yield attributes and grain yield upto 13.09 q/ha.

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