EFFECT OF SOWING METHODS AND WEED CONTROL TECHNIQUES ON YIELD AND YIELD COMPONENTS OF CHICKPEA

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ABSTRACT

Chickpea (Cicer arietinum L.) is a poor competitor to weeds, hence weeds are a serious constraint to increase the yield of chickpea. An experiment was conducted during 2004-05 and 2005-06 at Arid Zone Research Institute Bhakkar to study the role of sowing method in control of weeds and comparison of two weed control techniques as hand weeding and application of pre-emergence weedicide (pendimethalin) on yield and yield components of chickpea. It was concluded that flat sowing proved to be superior to ridge sowing in respect of weed control and hand weeding twice at 30 and 60 days after sowing (DAS) increased 15 and 43 % yield over pre-emergence application of pendimethalin and weedy check, respectively. Flat sowing cum hand weeding gave the maximum average yield value of 3039.88 kg ha^{-1} and weed infestation reduced 38 % chickpea yield. Weed characters such as weed density, fresh weed biomass and dry weed biomass per unit area, yield and yield components were significantly affected by sowing methods and weed control techniques. It was recommended that flat sowing with twice hand weeding at 30 and 60 days after sowing proved to be the best for weeds control in chickpea.

Key words: *Cicer arietinum*, sowing methods, weed control, hand weeding, chemical weed control.

INTRODUCTION

Weeds are a serious constraint in increasing production and easy harvesting in chickpea. Chickpea is a poor competitor to weeds because of slow growth rate and limited leaf area development at early stages of crop growth and establishment (Solh and Paik, 1990). Weeds share soil fertility, moisture, solar radiation and space needed for crop plants and hence result in yield reduction. Weeds also deteriorate the quality of farm produce and hence reducing the market value (Marwat *et al.*, 2005a).

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Yield losses due to weed competition vary considerably depending on the level of weed infestation and weed species prevailing. Nevertheless, almost all estimates reflect the seriousness of weed problem. Yield losses varied between 40 to 94 % (ICARDA, 1985. Bhan and Kukula, 1987). Al-Marsafy *et al.* (1986) estimated that seed yield losses are 46 % while the reduction amounted to16 % in straw yield. Another study shows that weeds cause 40-90 % seed yield losses in chickpea (Solh and Palk, 1990). Whish *et al.* (2002) narrated that loss in chickpea yield and yield components increased with increasing density of weeds. Even low weed densities of <10 plants m^{-2} caused large (approx 50%) reduction in yield and more yield losses in wider row spacing.

The common predominant weeds in chickpea fields were *Chenopodium album* L. (common lambsquaters), *Asphodelus tenufolius* L. (wild onion), *Polygonum aviculare* (knotweed), *Medicago denticulata* (burclover), *Lathyrus aphaca* (meadow peavine), *Vicia sativa (common vetch)*, *Phalaris minor* (littleseed canarygrass), *Cyperus rotundus* (purple nutsedge), *Cynodon dactylon* L. (bernuda grass), *Anagallis arvensis* (Scarlet pipmpernel) *Convolvulus arvensis* L. (field bindweed), *Melilotus indica* (Indian sweet clover), *Cirsium arvense* (canada thistle), *Avena fatua* L. (Wild oat) and *Fumaria indica* (fumitory).

Weeds emerge with the winter sown crops and create severe competition unless controlled timely and effectively. Inter-row cultivation is not sufficient and intra-row hand weeding is necessary under most conditions. There is, therefore, an urgent need to move from costly manual- mechanical weed control to an integrated weed control. In the more developed agricultural systems, herbicides have already replaced mechanical weed control (Klingman and Ashton, 1982).

Mohamed *et al.* (1997) conducted field studies to determine the yield losses due to weeds, role of sowing methods in weed control and to evaluate the pre-emergence herbicide treatment effect on yield and yield components of chickpea. Pre-emergence application of oxyfluorfen (0.24 kg a.i. ha^{-1}) and a supplementary hand weeding gave excellent control of weeds and increased yield by 57 % over the weedy check.

Manual weeding at 25 and 45 days after sowing (DAS) surpassed herbicide treatment in respect of seed yield. Un-checked weed growth reduced the mean seed yield of chickpea by 41.7 % as compared with manual

removal of weeds and it was concluded that manual weeding at 25 and 45 DAS, was the best weed control in chickpea (Vaishya *et al.* 1996). Singh and Sahu (1996) indicated that best yield of 2257 kg per ha ^{1} was obtained in chickpea by hand weeding at 60 days after planting (DAP). Of herbicide treatments, best yield of 1944 kg ha ^{1} was obtained with pendimethalin + hand weeding at 60 DAP.

Lyon and Wilson (2005) stated that yield of hand weeded chickpea exceeded as 1500% in irrigated system and 87 % in the dryland system over non-treated check. Pendimethalin and pendimethalin+dimethenamid-P applied as pre-emergence provided acceptable weed control in the irrigated system but did not in the dryland.

Mohammadi *et al.* (2005) studied the critical period of weed interference in chickpea on yield and yield components. Unweeded conditions for the entire growing season caused 48.3 to 66.4% seed yield reduction when compared with the weed free treatments. Yield reduction was accompanied with reduction in plant dry weight, number of branches, pods per plant and 100 seed weight.

Marwat *et al.* (2005b) recorded highest onion height in unweeded check because in competition between plants tended to invest more photosynthate into structural tissues to harvest light. Pre-plant or pre emergence incorporation of fluchloralin at 1.5 kg a.i. ha ^{1} significantly reduced the density and biomass of weeds and increased 58.2 % chickpea yield than that of weedy control (Singh and Singh, 1998). Seed yield could be increased upto 17-150 % with better weed control in chickpea (ICARDA, 1985).

Keeping in view the importance of weeds infestation in chickpea and their effects on yield losses, the present project was design to evaluate the efficiency of two sowing methods in controlling the weeds flora in chickpea. Similarly, the study was also aimed to compare hand weeding with application of pre-emergence pendimethalin and their effects on yield components.

MATERIALS AND METHODS

A field experiment was conducted at Arid Zone Research Institute, Bhakkar Punjab, Pakistan during Rabi (winter) season of 2004-05 and 2005-06 on sandy loam soil with field capacity and permanent wilting point values of 14.67 and 5.40% on volume basis, respectively. The research site is situated at latitude 31°37 N, longitude 71 ° 02E. The experimental land was

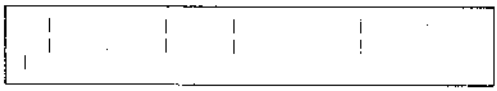
prepared by rotavating the guar crop as green manure 20 days before the sowing of experiment. The experimental treatments consisted of two sowing methods i.e. Flat (SM_1) and Ridge sowing (SM_2) and two weed control techniques alongwith weedy check i.e. Weedy check - W_0, Hand weeding- W_1(twice at 30 and 60 DAS) and pendimethalin 33% W/V- W_2 (Pre-emergence). The experiment was laid out in split plot design with two sowing methods in main plots and weed control techniques in sub plots. The crop was planted on 30th October and 7th November in 2004 and 2005, respectively on same experimental area. Two sowing methods i.e. flat and ridge sowing were tested in main plots and two weed control techniques along with weedy check using herbicide (pendimethalin) before emergence of crop and hand weeding twice at 30 and 60 days after sowing (DAS) were carried out. The treatments were replicated four times. The subplot size was 3.6 x 5 m^2 having row to row spacing of 30 cm in flat sowing and 15/45 cm among the ridges. The certified seed of chickpea variety "Bittle-98" was used as test material. Row to row and plant-plant distance was maintained at 30 cm and 10 cm, respectively. The seed was sown with a single row drill and 30 days old seedlings were thinned to establish the plant-plant distance. Before sowing, a soaking dose of water was applied to the whole experimental area to obtained uniform germination. The recommended dose of fertilizer i.e. 22 Kg N and 57 Kg P_2O_5 ha^{-1} was applied in the form of urea and triple super phosphate at the time of seed bed preparation. The first post planting irrigation was applied 45 days after germination and subsequent irrigations were applied according to the crop requirements depending upon the weather conditions. Weed samples were collected 60 and 90 days after sowing (30 days after treatment application) using a quadrate of 1 m^2. Fresh weed biomass was taken and then oven dried at 70 ^{0}C for 72 hours for recording dry weed biomass. The detail of treatments is as under:-

Main plots		**Sub-plots**	
Sowing methods (SM)		**Weed control techniques (W)**	
SM_1	= Flat sowing	W_0	= Weedy check
SM_2	= Ridge sowing	W_1	= Hand weeding (twice at 30 and 60 DAS)
		W_2	= Pendimethalin 33% W/V (Pre-emergence)

Data were recorded on number of weeds m^{-2} on 60 and 90 days after sowing on plot basis, plant height (cm), number of pods $plant^{-1}$ and number of seeds pod^{-1} were recorded on 10 randomly selected plants from each plot. Average weight of three samples was recorded for 100 seed randomly taken from grain yield of each replication where as grain yield (kg ha^{-1}) was recorded by harvesting plots leaving side rows as non experimental. Data were subjected to Analysis of variance (Steel and Torrie, 1984) to determine the significance of differences between treatments. Least significance

difference (LSD) test was applied for comparison of means of individual treatments.

Sowing plan:



Flat sowing having 30 cm row spacing cm)

Two row strip sowing on ridges (15/45

RESULTS AND DISCUSSION

Weed density m^{-2}

Results of analysis of variance of sowing methods (SM) and weed control techniques (W) were statistically significant. The interaction between SM and W was also significant for all the parameters studied except number of seeds pod^{-1} during 2005-06.

Weed density data presented in Table-1 showed that the differences between the treatment means were significant and maximum number of weeds m^{-2} were recorded in ridge sowing as 6.32 and 8.11 at 60 DAS and 90DAS, respectively during 2004-05. On average, the weeds density was increased 59 % in ridge sowing and hence decreased yield and similar trend was observed during the 2nd year of experimentation. Dense weed population in ridges might be due to more space between the ridges and crop plants took more time to cover the soil surface. Maximum weed density was recorded in weedy check as 10.79 and 14.36 at 60 and 90 DAS followed by chemical weed control, having weed density of 2.31 and 3.99 at 60 and 90 DAS. Thus hand weeding and pendimethalin gave 85 and 75 % weed control during 2004-05, respectively. Similarly higher weed density was observed during 2005-06 as 17.67 and 22.56 weeds m^{-2} in weedy check after 60 and 90 DAS. Minimum weed density was recorded in hand weeding during both the years of trial giving 79 % weed control against weedy check. These findings are in line with that of Singh and Sahu (1996) and Mohamed *et al.* (1997) who narrated that hand weeding gave excellent control of weeds and increased seed yield by 57 % over the weedy check.

As far as interaction of sowing methods and weed control technique is concerned, significant higher weed density was observed in SM_2 x W_0 (ridge sowing x weedy check) during both the years at 60 and 90 DAS. Minimum weed population was observed in SM_1 x W_1 (flat sowing x hand weeding) giving 89 and 83 % weeds control during 2004-05 and 2005-06, respectively. Similarly, Whish *et al.* (2002) narrated that loss in chickpea yield and yield components increased with increasing density of weeds and weeds density ncreased with increased row spacing.

Dry weed biomass (g m^{-2})

Maximum dry weed biomass was observed in ridge sowing as 26.20 (60DAS) and 68.76 g m^{-2} (90DAS) during 2004-05 (Table-1). Similarly, the highest dry weed biomass (15.85 and 43.82 g m^{-2}) was observed in ridge sown plots during 2005-06 (Table-1).The dry weed biomass was decreased 17 and 22 % in flat sowing against ridge sowing during 2004-05 and 2005-06, respectively. Accordingly, Whish *et al.* (2002) reported that chickpea sown in 32 cm rows gave more yield compared with 64 cm rows, weed density and biomass was increased in wider rows. Weedy check had maximum significant dry weed biomass as 59.17 and 182.88 g m^{-2} at 60 and 90 DAS during 2004-05 (Table-1) and 36.29 and 107.82 g m^{-2} at 60 and 90 DAS during 2005-06 (Table-1). Minimum values for dry weed biomass were recorded in hand weeding during both the years. Thus hand weeding decreased 98 % dry weed biomass against weedy check. These findings are in line with that of Balyan and Malik (1996) who revealed that weed biomass was reduced incorporating hand weeding. The interactions between sowing methods and weed control techniques showed the significant differences and maximum dry weed biomass (193.64 g m^{-2}) was recorded for ridge sowing cum weedy check. It may be due to more space between the ridges (15/45 cm) compared to flat sowing (30 cm), more light interception and more vigorous growth of weeds and hence more accumulation of biomass and minimum weed dry biomass (0.89 g m^{-2} at 60 DAS & 2.45 g m^{-2} at 90 DAS) was recorded in flat sowing x hand weeding during 2004-05. Similar trend was observed in the second year of investigation.

Plant height (cm)

Plant height is a very important character especially in chickpea and highly influenced by environmental conditions and cultural practices. The sowing method significantly affected plant height and plants gained more height (11 %) in ridge sown plots (65.59 and 56.85 cm) than that of flat sowing (58.05 and 51.79 cm) during 2004-05 and 2005-06, respectively (Table-2). It may be due to more light interception and air circulation in ridges by weed plants and secondary, the root zone in ridges may be less compact compared with flat sowing which facilitated early root development and hence affected the plant height. The more height (66.22 and 58.33 cm) was attained in the weedy check because of competition between crop plants and weeds to harvest more light. On average, plant height was increased 14.40 % due to weed-crop competition in weedy check. These findings are in accordance with that of Marwat *et al.* (2005[a]) who recorded highest onion height in weedy check. In weedy check the crop plants invested photosynthate in attaining the vegetative superiority for shading weeds and minimum plant height (58.12 and 50.76 cm) was observed in hand weeded plots during 2004-05 and 2005-06, respectively.

The interactions were also significant and maximum chickpea plant height was recorded in ridge sowing cum weedy check as 69.30 and 59.28 cm giving 27 % increase in crop plant height due to crop-weed competition and minimum plant height was recorded in flat cum hand weeding as 54.77 and 46.35 cm during 2004-05 and 2005-06, respectively.

Number of pods plant^{-1}

Data regarding number of pods plant^{-1} presented in Table-2 showed significant differences among the treatments. Maximum number of pods plant^{-1} (35.93 and 43.44) were obtained in flat sowing during both the years of study. Hand weeding gave maximum number of pods plant^{-1} (41.26 and 46.71) followed by chemical weed control (Pre-emergence pendimethalin) as 32.32 and 41.83 pods plant^{-1}during the first and second year, respectively. Minimum pods per plant (30.92 and 34.96) were recorded in weedy check during both the years of probe. Weed infestation decreased number of pods plant^{-1} by 25 %. The interactions between sowing methods and weed control techniques were also significant and the highest values for number of pods plant^{-1} were recorded in flat x hand weeding (44.97 and 51.65) and lowest ones were recorded in respect of ridge cum weedy check plots (31.27 and 34.68) during 2004-05 and 2005-06, respectively. Maximum reduction (32 %) in number of pods plant^{-1} was recorded in ridge sowing cum weedy check thus reducing the yield and yield components. It might be inferred that more weeds density in ridge sown plots created more competition with crop plants for light, space and nutrients, therefore, crop plants invested more photosynthates plant height and resultantly less pod setting was recorded. Our results can get support from that of Singh and Singh (1998) and ICARDA (1985).

Number of seeds pod^{-1}

Data for number of seeds pod^{-1} showed significant differences during 2004-05 and non-significant during the next growing season in respect of sowing method. However, flat sowing gave the higher number of seeds pod^{-1}. Regarding weed control technique, hand weeding gave the maximum number seeds pod^{-1} (1.89 and 1.92) followed by chemical weed control- Pre-emergence, pendimethalin (1.69 and 1.74) during both years of study. Weedy check gave the minimum number of seeds pod^{-1} (1.62 and 1.64) during 2004-05 and 2005-06, respectively (Table-3). Thus number of seeds pod^{-1} were reduced 15 % due to weeds infestation. These results are in concurrence with that of Qurashi *et al.* (2002) who reported that seed number was improved by hand weeding.

Significant effects were also recorded in treatment interactions during the course of study and maximum number of seeds pod^{-1} (1.96 and 1.96) were recorded in flat cum hand weeding and minimum seeds pod^{-1} (1.68 and

1.63) were observed in ridge sowing cum weedy check. Numbers of seeds pod-1 were reduced 18 % due to weed infestation in ridge sowing x weedy check. These results are in concurrence with that of Mohammadi *et al.* (2005) who reported that un-weeded condition reduced the yield of chickpea accompanied with the reduction of plant dry biomass, number of branches, pods plant^{-1}, seeds pod^{-1} and 100 seed weight.

100 seed weight (g)

The analysis of variance revealed that the differences between the means of values were significant (Table-3). Flat sowing gave more 100 seed weight (26.89 g) as compared to ridge sowing (25.11 g) during 2004-05. Similarly maximum 100 seed weight of 32.07 g was recorded in flat sowing against 30.46 g in ridge sowing during 2005-06. Thus 100 seed weight was 7 % more in flat sowing as compared to ridge sown plots. It might be due to the facts that weeds gave tough time to crop plants in ridges, resultantly reduced the yield and yield components. Hand weeding gave the maximum values of 27.49 and 33.05 g per 100 seed weight thus giving an increase of 11.03 and 11.10% in 100 seed weight over weedy check. Minimum 100 seed weight of 24.76 and 29.72 g was recorded in respect of weedy check (24.76 and 29.72 g) during 2004-05 and 2005-06, respectively. The interactions between the treatment means also showed the significant differences. Maximum 100 seed weight was recorded in respect of flat sowing x hand weeding as 28.32 and 34.57 g and lowest 100 seeds weight of 24.11 and 29.61 g in ridge sowing cum weedy check during 2004-05 and 2005-06, respectively causing 15 % decrease in 100 seed weight due to weeds infestation in ridge sown crop. It might be inferred that crop plants invested maximum photosynthate to overcome the weeds and 100 seed weight has been reduced. These findings are in accordance with those of Vaishya *et al.* 1996, Qurashi *et al.* (2002) and Mohammadi *et al.* (2005) who stated that unchecked weeds reduced 100 seeds weight and thus the yield.

Seed yield kg ha^{-1}

Seed yield, the end product, gave the significant differences among the treatments. The data in table-3 further indicated that flat sowing (1997.25 and 3112.75 kg ha^{-1}) surpassed the ridge sowing (1769.83 and 2715.50 kg ha^{-1}) during both the growing seasons, respectively. Thus seed yield was increased 14 % in flat sowing. Flat sowing might superior to ridge sowing due to less weed intensity which caused the improvement in yield and yield components. Maximum yield of 2271.50 and 3320.00 kg ha^{-1} was recorded in hand weeding followed by pre-emergence application of pendimethalin which gave the yield values of 1954.38 and 2932.13 kg ha^{-1} and the lowest yield was recorded in weedy check as 1424.75 and 2490.75 kg ha^{-1}during 2004-05 and 2005-06, respectively showing approximately 30 % reduction in yield due to weeds infestation. It may be due to the fact that

weeds shared plant nutrients, soil fertility, moisture, solar radiation and available space and resulted in yield reduction. These results are in confirmation to that of Lyon and Wilson (2005), Mohammadi *et al.* (2005), Singh and Singh (1998), Mohamed *et al.* (1997), Vaishya *et al.* (1996) who reported that unchecked weeds reduced the economical yield in chickpea accompanied with decrease in plant dry weight, number of branches, number of pods per plant and 100 seed weight. Similarly Sharma *et al.* (2001) observed 21% decrease in seed yield in weedy check.

The interactions between sowing methods and weed control techniques gave significant differences and maximum seed yield was recorded in respect of flat sowing x hand weeding as 3039.88 kg ha^{-1} (two years average) and minimum seed yield of 1883.13 kg ha^{-1} was recorded in ridge sowing x weedy check. Thus yield was reduced 38% due to weed infestation. The greater differences were observed in yield values during the 1^{st} and 2^{nd} years investigation and it might be due to the fact that chickpea crop requires less water for its better growth and yield but during the 1^{st} year of study frequent rains had adversely affected the chickpea yield by increasing weed density, weed growth, crop plant height, lodging, flower dropage and consequently the less yield. These findings are in line with that of Hassan and Sarkar (1999) who stated that over irrigation (more than three irrigations) gradually decreased yield and yield components of chickpea and water use efficiency causing the wastage of irrigation water. From the above studies, it may be concluded that flat sowing cum hand weeding proved to be the best for weeds control in chickpea at 30 and 60 days after sowing.

Table-1. Weed parameters as affected by various weed control techniques during 2004-05 and 2005-06.

Treatment	Weed density (m^{-2}) 2004-05		Dry weed biomass ($g\ m^{-2}$) 2004-05		Weed density (m^{-2}) 2005-06		Dry weed biomass ($g\ m^{-2}$) 2005-06	
	60DAS	90 DAS	60 DAS	90DAS	60 DAS	90DAS	60 DAS	90DAS
A- Sowing method								
Flat sowing(SM_1)	3.65b	5.41b	18.36b	59.99b	7.93b	10.33b	12.21b	34.54b
Ridge sowing(SM_2)	6.32a	8.11a	26.20a	68.76a	9.42a	12.87a	15.85a	43.82a
$LSD_{0.05}$	**0.12**	**0.52**	**2.72**	**5.81**	**0.38**	**1.85**	**0.68**	**3.93**
B- Weed control technique								
Weed check (W_0)	10.79a	14.36a	59.17a	182.88a	17.67a	22.56a	36.29a	107.82a
Hand weeding (W_1)	1.86c	1.93c	1.39c	3.55c	3.69c	5.07c	1.33c	3.24c
Chem. Weed control(W_2)	2.31b	3.99b	6.28b	6.70b	4.97b	7.18b	4.47b	6.47b
$LSD_{0.05}$	**0.44**	**0.52**	**1.11**	**1.72**	**0.24**	**0.42**	**1.01**	**2.87**
C- Sowing method x Weed control technique								
$SM_1 x\ W_0$	7.29b	11.95b	50.24b	172.10b	15.22b	20.25b	36.64b	98.14b
$SM_1 x\ W_1$	1.79d	1.53e	0.98e	2.45e	3.67d	4.35f	0.91e	1.42d
$SM_1 x\ W_2$	1.88d	2.77d	3.86d	5.42d	4.91c	6.41d	3.06d	4.05d
$SM_2 x\ W_0$	14.30a	16.78a	68.11a	193.64a	20.13a	24.88a	39.95a	117.50a
$SM_2 x\ W_1$	1.93d	2.34d	1.81e	4.65de	3.72d	5.80e	1.74de	5.05cd
$SM_2 x\ W_2$	2.74c	5.23c	8.69c	7.98c	5.03c	7.95c	5.88c	8.89c
$LSD_{0.05}$	**0.62**	**0.74**	**1.57**	**2.43**	**0.33**	**0.59**	**1.43**	**4.06**

Means followed by the same letter in a column do not differ significantly at 5 % level of probability

Table-2. Effect of sowing methods and weed control techniques on some morphological and yield components of chickpea

Treatment	Plant height (cm)		Number of pods plant^{-1}		Number of seeds pod^{-1}	
	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06
A- Sowing method						
Flat sowing(SM_1)	58.05b	51.79b	35.93a	43.44a	1.80a	1.780
Ridge sowing(SM_2)	65.59a	56. 85a	33.73b	38.89b	1.67b	1.750
$LSD_{0.05}$	**2.42**	**2.19**	**1.98**	**3.18**	**0.071**	**NS**
B-Weed control technique						
Weedy check (W_0)	66.22a	58.33a	30.92c	34.96c	1.619c	1.640c
Hand weeding(W_1)	58.12c	50.76c	41.26a	46.71a	1.891a	1.920a
Chem. Weed control(W_2)	61.12b	53.88b	32.32b	41.83b	1.688b	1.740b
$LSD_{0.05}$	**1.14**	**1.16**	**1.02**	**1.03**	**0.034**	**0.077**
C- Sowing method x Weed control technique						
$SM_1 x W_0$	63.14c	57.38b	30.57d	35.25e	1.675d	1.630c
$SM_1 x W_1$	54.77e	46.35e	44.97a	51.65a	1.957a	1.961a
$SM_1 x W_2$	56.25e	51.65d	32.27c	43.43b	1.763c	1.760b
$SM_2 x W_0$	69.30a	59.28a	31.27cd	34.68e	1.563f	1.650bc
$SM_2 x W_1$	61.47d	55.18c	37.55b	41.78c	1.825b	1.881a
$SM_2 x W_2$	65.99b	56.10bc	32.38c	40.23d	1.612e	1.710bc
$LSD_{0.05}$	**1.61**	**1.64**	**1.44**	**1.45**	**0.049**	**0.109**

NS=Non-Significant.

Means followed by the same letter in a column do not differ significantly at 5 % level of probability

Table – 3. Effect of sowing methods and weed control techniques on 100 seed weight and yield of chickpea

Treatment	100 seed weight (g)		Seed yield (kg ha^{-1})	
	2004-05	2005-06	2004-05	2005-06
A- Sowing method				
Flat sowing(SM_1)	26.89a	32.07a	1997.25a	3112.75a
Ridge sowing(SM_2)	25.11b	30.46b	1769.83b	2715.50b
$LSD_{0.05}$	**0.439**	**0.201**	**33.92**	**36.49**
B-Weed control technique				
Weedy check (W_0)	24.76c	29.72c	1424.75c	2490.75c
Hand weeding (W_1)	27.49a	33.02a	2271.50a	3320.00a
Chem. Weed control(W_2)	25.75b	31.05b	1954.38b	2932.13b
$LSD_{0.05}$	**0.260**	**0.103**	**30.54**	**34.84**
C- Sowing method x Weed control technique				
$SM_1 x W_0$	25.42c	29.83e	1448.75d	2615.00e
$SM_1 x W_1$	28.32a	34.57a	2454.50a	3625.25a
$SM_1 x W_2$	26.94b	31.81b	2088.50b	3098.00b
$SM_2 x W_0$	24.11e	29.61f	1400.75e	2365.50f
$SM_2 x W_1$	26.67b	31.46c	2088.50b	3014.75c
$SM_2 x W_2$	24.56d	30.29d	1820.25c	2766.25d
$LSD_{0.05}$	**0.368**	**0.146**	**43.19**	**49.30**

Means followed by the same letter in a column do not differ significantly at 5 % level of probability

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