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Studies on the effect of weed suppression through, on the growth parameter, yield and economics of the Lentil crop (*Lens culinaris* Medick)

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Abstract
A field experiment conducted during *Rabi* season 2013-2014 at Students Instructional farm, Department of Agronomy, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U.P.). To find out studies the effect of the weed suppression through, mechanical, cultural and chemical method of weed control of the Lentil crop (*Lens culinaris* Medick) Practices where variety KLS-218 and conventional tillage along with two hand weeding was done gives higher grain and straw yield comparison to all. Other treatments also recorded higher net income and B: C Ratio. This experiment was done where soil was sandy loam in texture. Organic carbon was about 0.5% and nitrogen content was low, medium in phosphorus and potassium availability. The pH7.7 indicates that the soil was slightly alkaline in reaction.

Keywords: growth parameter, economics, lentil crop

Introduction
India is a major pulse growing country in the world sharing 35.56 and 27.28 percent of total area and production of these crops, respectively (Anonymous, 2011-2012) [1].
Pulses are the main source of protein to the vegetarian population of India. More than half of Indian population's vegetarian and such people use pulses to fulfill their protein requirement because they cannot opt for animal protein, as it is very expensive as well as religion and social culture of the country. The lysine rich protein of pulses is considered to supplement the deficiency of amino acid in the cereal dietaries and bring at par with milk protein in term of biological efficiency. It is because of this reason that pulses have also been called the "Poor man's' Meat".
As per the report of W.H.O. the minimum requirement of pulse is 85g/day/capita during 2011-12. In India per capita consumption of pulse has been declining sharply due to growth of population, the importance of pulse in our daily diet as well as agricultural food production, unfortunately pulse production has not yet been increase proportionately as increase in cereal production.
Lentil was first gown in South West Asia about 7000 B.C., it is best adapted to the cool or temperate zone of the world or the winter season in Mediterranean climates, split lentil (Dal) is an important source of dietary protein in the Mediterranean and South Asian regions.
Lentil is a very important pulse crop in Western Canada. It is grown to improve economic returns to producers. Diversity and crop rotations reduce the requirement for nitrogen fertilizer. Lentil is a member of the Legume family. Leguminosae, can supply a significant part of its nitrogen requirement by fixing nitrogen from the air when inoculated with the appropriate rhizobial inoculants.
Lentil seed size is classified in two types: large- seeded (greater than 50 grams per 1000 seeds) and small seeded (45 grams or less per 1000 seeds). The two main market classes are green and red. Green lentil is usually marketed as whole seed.
While red lentil is marketed as whole seed or in de-hulled and split form. The majority of world lentil production and trade is in red lentil. Seed coat colour can varies from clear to light green to deep purple, mottled, grey, brown or black. Cotyledon (seed leaf) colour is yellow, red or green. The predominant lentil grown in western Canada is the large seeded green type, such as the variety CPC Sovereign, but red lentils are rapidly gaining popularity.

Lentil is one of the important r*abi* pulse. It has the potential to cover the risk of dry land areas. It is also used as a cover crops, to check the soil erosion. It is mostly eaten as "Dal" the pulse is first converted in to split pulse or Dal by removal of the skin and separation of fleshy cotyledon, while pulse grain is also used in some of the dishes. It is cooked early and hence preferred to the dry leaves and stem empty pods and broking bits all are used as cattle feed. Lentil contains about 12% water, 25% protein and 60% carbohydrate. It is also rich in calcium, iron and Niacin.

Lentil requires cold climate and sown as winter seasons crop. It is very hardy, and can tolerate frost over winter to great extent. It requires cold temperature during vegetative growth and warm at the time of maturity. The optimum temperature for growth is 18-30^{0}C.

Weed are the major constraints to lentil production in the central plane zone of U.P. Tillage systems, herbicide and the timing of such operations significantly influence the weed density and yield of lentil.

The important pulses growing countries of the world are Canada, India, Turkey, Syria, Pakistan, Spain and Bangladesh. Lentil is mostly grown in northern plains, central and eastern part of India. In India, lentil is the second most important legume of r*abi* season after chickpea, with an area of 15 lakh ha, with the production of 9.50 lakh tones and productivity of 6.33 q ha^{-1} (Anonymous, 2012) [1]. Area, production and productivity of lentil in U.P. were 5.73 lakh ha, of 4.10 lakh tones and 7.15 q ha^{-1}, respectively (Anonymous, 2011-12) [1]. Lentil is an important winter season pulse crop in India, it is hardier and capable of withstanding extremes of weather and soil conditions. However, due to its short stature, slow initial growth and long duration, its productivity is adversely affected by the presence of weeds. As per an estimate of the reduction in yield may be up to 74% (Balyan *et al*. 1997). Hand weeding and hoeing are the conventional and more effective practices of weed removal in pulses. These practices have certain limitations like non – availability of labors at right time as well as due to higher wages. Under such situation the use of selective herbicides may provide more effective and economical control of weeds as compared to manual weeding. Weeds compete with plants for natural resources during cultivation and reduce the yield of lentil up to 87% (Punia *et al*., 2003) [5].

Materials and Methods

The present experiment was carried out during *Rabi*, 2013-14 in field number. (7) at Students Instructional Farm, Department of Agronomy, Chandra Shekhar Azad University of Agricultural and Technology, Kanpur. The experiment consists of 12 treatments viz., (T_1) Zero Tillage KLB-320 weedy, (T_2) Zero Tillage, KLB-320, HW (30 &45 DAS), (T_3) Zero Tillage, KLB-320, pendimethalin @ 1 kg ai/ha, (T_4) Zero Tillage, KLS-218, weedy, (T_5) Zero Tillage, KLS-218, HW (30 &45 DAS), (T_6) Zero Tillage, KLS-218,pendimethalin @ 1 kg ai/ha, (T_7) Conventional Tillage, KLB-320, weedy, (T_8) Conventional Tillage, KLB-320, HW (30 &45 DAS), (T_9) Conventional Tillage, KLB-320, pendimethalin @ 1 kg ai/ha, (T_{10}) Conventional Tillage, KLS-218, weedy, (T_{11}) Conventional Tillage, KLS-218, HW (30 &45 DAS) and (T_{12}) Conventional Tillage, KLS-218, pendimethalin @ 1 kg ai/ha. The crop was fed with Urea @ 35.00 kg, DAP 130 kg and MOP 60 kg/ha to supply 40 kg N, 40 kg P_2O_5 and 20 kg/ K_2O/ha. All required fertilizer was applied before sowing as plough sole placement.

Soil Analysis

To find out the physical and chemical properties of soil of experimental field, the soil samples were collected randomly from number of place up to depth of 8-10 cm, with the help of *Khurpi*. The soil sample mixed the thoroughly together and a composite sample was drawn for the purpose of analysis.

The preparation of various soil separates with textural classes was decided by triangle method. Mechanical analysis of soil was done by hydrometer method as suggested by Bougroues (1962) [2]. Available P_2O_5 was determined by Olsen method explained by Olsen (1954) [4]. Flame Photometer Method was used for the estimation of available K_2O. Organic carbon (%) and nitrogen content was low, medium in phosphorus and potassium availability. The pH 7.7 indicates that the soil was slightly saline in reaction.

Studies on crop

1. Pre-harvest studies

The final plant population was recorded from three places selected randomly in each plot 90 days after sowing. A quadrate of 0.5m x 0.5 m was used for the purpose. Finally it is reported as number of final plant m^2. The plant height was measured from the ground level to the top of the plant with the help of meter scale on 5 randomly selected plant and average out of five plants, recorded in cm. The branches were counted on tagged five plant and the mean values were taken as the number of branches per plant.

2. Post-harvest studies

Three plants were randomly selected from each net plot for post- harvest studies. Such as number of pods plant^{-1}**,** average number of grains per plant, and grain yield per plant was calculated. Total number of pods of 3 selected plants were counted and averaged. At random 25 filled pod were selected from the sample plant for this purpose some pod have two grain and some have one grain And threshed. Total Number of grains were counted and averaged.

All the pods from three plants were threshed and grain weight was recorded. It was average to report as grain/plant in grams. Samples comprising 1000-grains were drawn irrespective of shape and size from the produce of each plot and weighted. Total weight of grains obtained from the net plot (4.0x3.6m) area was recorded at 9 percent grain moisture. The moisture was determined by moisture meter. The quantity of straw yield was calculated by subtracting the grain yield from the biological yield of each plot. The recovery of grain from yield dry matter was considered as Harvest index (HI) which is expressed in percentage. It was calculated by the following formula.

$$\text{H.I. (\%)} = \frac{grain\ yield}{biological\ yield} \text{ X } 100$$

The protein content in grains was obtained by analyzing the grain for total nitrogen content by Kjeledahl's method (A.O.A.C.1883) and multiplying the nitrogen percentage by 6.25, a constant factor.

Net income in term of rupees was worked out one hectare basis. Common cost of cultivation as well as treatment- wise cost of cultivation worked out at the rates prevailing during

2013-14. The net income was calculated by subtracting the total cost of cultivation from the total income obtained from grain and straw yields. Net income per rupee investment was also calculated by the following formula:-

$$\text{B.C.} = \frac{Grass\ income\ (Rs.)}{Total\ cost\ of\ cultivation\ (Rs.)}$$

Result and Discussion

The data presented in table-1. The data revealed that plant population was not significantly affected by tillage practices, but was observed that numerically higher plant population recorded under conventional tillage between the variety significantly higher plant populations was recorded under the variety of KLS-218. Among the weed management practices the higher plant population was recorded under than two hands weeding at (30 and 45 days after sowing) followed by when applied pendimethalin @ 1.0 kg ai/ha and significantly minimum plant population was observed under the weedy check plot.

Table 1: Final Plant Population/$m^2$and Plant dry weight/plant at 90 days after sowing (DAS)

Treatment	Final Plant population (m^2)	Plant dry wt/plant (g)
Tillage		
Zero tillage	41.000	13.78
Conventional	42.600	15.95
SE(m)±	0.410	0.180
C.D. (P=0.05)	N.S.	1.110
Variety		
KLB-320	41.111	14.45
KLS-218	42.5	15.28
SE(m) ±	0.142	0.136
C.D. (P=0.05)	0.553	0.531
Weed Control		
Weedy	40.33	13.63
Two hand weeding	43.33	15.83
Pendimethalin@1kgai/ha	42.10	15.15
SE(m) ±	0.405	0.327
C.D. (P=0.05)	0.860	0.979

Plant dry weight at 90 days after sowing

The data depicted in table-1. The perusal of data shows that plant dry weight was significantly affected by tillage, varieties and weed management practices. It was observed that numerically higher plant dry weight was recorded under conventional tillage between the varieties significantly higher plant dry weight was recorded under the variety of KLS-218. Among weed management practices the higher plant dry weight was recorded under two hand weeding (30 and 45 days after sowing followed by when applied pendimethalin @ 1.0 kg ai/ha. and significantly minimum plant dry weight was observed under the weedy check plot.

Plant height at 60 and 90 days after sowing

The data related to plant height depicted in table-2. Plant height shows significant result both at 60 and 90 days after sowing. But were observed that numerically higher plant height was recorded under conventional tillage between the varieties significantly higher plant height was recorded under the variety of KLS-218. Among the weed management practices the higher plant height both 60 and 90 days after sowing were recorded under two hand weeding at30 and 45 days after sowing followed by when applied pendimethalin @ 1.0 kg ai/ ha and significantly minimum plant height was observed under the weedy check plot.

Table 2: Plant height (cm) at 60 and 90 days after sowing

Treatment	Plant height (cm)	
	60 DAS	90 DAS
Tillage		
Zero tillage	13.64	14.64
Conventional	15.82	16.82
SE(m)±	0.075	0.074
C.D. (P=0.05)	0.461	0.459
Variety		
KLB-320	14.15	15.15
KLS-218	15.31	16.31
SE(m) ±	0.088	0.088
C.D. (P=0.05)	0.343	0.343
Weed Control		
Weedy	13.83	14.83
Two hand weeding	15.93	16.93
Pendimethalin@1kgai/ha	14.43	15.43
SE(m) ±	0.372	0.372
C.D. (P=0.05)	1.114	1.114

Number of branches/ plant at 90 days after sowing

The data related to number of branches/ plant depicted in table-3. The perusal of data revealed that no. of branches/plant was significantly affected by tillage practices. It was observed that numerically higher number of branches/plant recorded under the conventional tillage. Between the varieties significantly difference was not observed to each other higher. Among the weed management practices the higher number of branches/plant was recorded under two hand weeding at 30 and 45 days after sowing followed by when applied pendimethalin @ 1.0 kg ai/ha and significantly minimum number of branches was observed under the weedy check plot.

Table 3: Number of branches/plant at 90 days after sowing.

Treatment	Number of branches /plant at 90 DAS
Tillage	
Zero tillage	8.27
Conventional	10.27
SE(m)±	0.136
C.D. (P=0.05)	0.840
Variety	
KLB-320	8.77
KLS-218	9.77
SE(m) ±	0.304
C.D. (P=0.05)	NS
Weed Control	
Weedy	8.16
Two hand weeding	10.16
Pendimethalin@1kgai/ha	10.12
SE(m) ±	0.551
C.D. (P=0.05)	1.168

Number of pod/plant

The data presented in table-4. The perusal of data revealed that no. of pod/plot was not significantly affected by tillage practices. It was observed that numerically higher number of pod/plant recorded under the conventional tillage. Between the varieties significantly higher no. of pods/ per plant was recorded under the variety of KLS-218. Among the weed management practices the higher no. of pod/ plant was recorded under two hand weeding at 30 and 45 days after

sowing followed by when applied pendimethalin @ 1.0 kg ai/ha and significantly minimum no. of pod/plant was observed under the weedy check plot.

Table 4: Number of pod and grain/plant

Treatment	No. of pod/plant	No. of grains/plant
Tillage		
Zero tillage	158.50	236.01
Conventional	176.22	265.53
SE(m)±	3.397	6.023
C.D. (P=0.05)	NS	NS
Variety		
KLB-320	161.11	241.55
KLS-218	173.61	260.00
SE(m) ±	2.565	4.040
C.D. (P=0.05)	10.013	15.775
Weed Control		
Weedy	137.41	206.05
Two hand weeding	184.91	275.45
Pendimethalin@1kgai/ha	179.75	270.82
SE(m) ±	3.788	4.577
C.D. (P=0.05)	11.35	13.723

Number of grain/plant

The data presented in table-4. The perusal of data revealed that number of grain/plant was not significantly affected by tillage practices. It was observed that numerically higher no. of grain/plant recorded under conventional tillage. Between the varieties significantly higher number of grain/plant was recorded under the variety of KLS-218. Among the weed management practices the higher no. of grain/plant was recorded under two hand weeding at 30 and 45 days after sowing followed by when applied pendimethalin @ 1.0 kg ai/ha and significantly minimum no. of grain/plant was observed under the weedy check plot.

Test weight 1000 grain weight in gram

The data depicted in table-5. The perusal of data shows that test weight was non-significantly affected by tillage, varieties and weed management practices. It was observed that numerically higher test weight was recorded under the conventional tillage. Between the varieties the non-significantly higher test weight was recorded under the variety of KLS-218. Among weed management practices the higher test weight was recorded under two hand weeding at 30 and 45 days after sowing followed by when applied pendimethalin @ 1.0 kg ai/ha and non-significantly minimum test weight was observed under the weedy check plot.

Table 5: Test weight (1000 grain weight)

Treatment	Test weight (g)
Tillage	
Zero tillage	20.37
Conventional	20.58
SE(m)±	0.010
C.D. (P=0.05)	NS
Variety	
KLB-320	20.42
KLS-218	20.53
SE(m) ±	0.013
C.D. (P=0.05)	NS
Weed Control	
Weedy	20.35
Two hand weeding	20.60
Pendimethalin@1kgai/ha	20.48
SE(m) ±	0.026
C.D. (P=0.05)	NS

Grain yield

The data pertaining to grain yield of lentil as depicted in table-6. The perusal of data revealed that grain yield was significantly affected by tillage practices. It was observed that numerically higher grain yield recorded under the "conventional tillage, between the varieties non significantly higher grain yield was recorded under the variety of KLS-218. Among the weed management practices the higher grain yield was recorded fewer than two hands weeding at 30 and 45 days after sowing followed by when applied pendimethalin @ 1.0 kg ai/ha and significantly minimum grain yield was observed under the weedy check plot.

Straw yield

The data pertaining to straw yield of lentil as depicted by various weed management practices have been presented in table-6. The crop affected by tillage, varieties and weed control practices. It was observed that straw yield not significantly affected by tillage and varieties. In weed control practices the significantly maximum straw yield (3727 kg/ha) was recorded under the treatment of hand weeding twice followed by under application of pendimethalin @ 1.0 kg ai/ha and significantly minimum straw yield was observed in weedy check plot.

Table 6: Yield and Harvest Index

Treatment combination	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest index (%)
Tillage			
Zero tillage	1867.25	3387.33	35.69
Conventional	2006.14	3726.62	34.99
SE(m)±	9.45	115.82	1.035
C.D. (P=0.05)	58.35	NS	NS
Variety			
KLB-320	1898.11	3514.55	35.22
KLS-218	1975.28	3599.45	35.46
SE(m) ±	53.32	48.27	0.611
C.D. (P=0.05)	NS	NS	NS
Weed Control			
Weedy	1793.95	3362.13	33.93
Two hand weeding	2094.87	3726.78	37.01
Pendimethalin@1kgai/ha	1921.26	3582.09	35.08
SE(m) ±	58.58	103.23	0.505
C.D. (P=0.05)	175.671	175.82	1.514

Harvest index

The data pertaining to harvest index of lentil was depicted by various weed management practices have been presented in table-6. Harvest index of crop affected by tillage varieties and weed control practices. It was observed that harvest index not significantly affected by tillage and varieties. In weed control practices the significantly maximum harvest index (37) was recorded under hand weeding twice followed by under application of pendimethalin @ 1.0 kg ai/ha and significantly minimum harvest index was observed in weedy check plot.

Economics

Any agro- technique or practices may get favor to the farmer only when those techniques of practices will be profitable to the farmers there to find out economic feasibility under the treatment of tillage, varieties and weed control treatment were worked out economics and analyzed the data of experimental plot for the benefit to the farmers for general adoption. The economic parameter such as cost of cultivation, gross income, net income and benefit- cost ratio was computed.

Economics of production of important aspect to adjust the efficiency of different production system based on physical feasibility and its economical viability. While calculating the economics cost of cultivation, gross-income, net income, B:C ratio were taken in to consideration in production of lentil herbicide applied, manual labor used, and common application cost.

Table 7: Gross income, net income, B: C ratio

Treatment combination	Gross income (Rs/ha)	Net income (Rs/ha)	Cost (Rs/ha)	B:C ratio
Tillage				
Zero tillage	106912	54253	54959	1.95
Conventional	115213	59754	55459	2.08
SE(m)±	4510.01	589.57	---	0.014
C.D. (P=0.05)	NS	3637.31	---	0.087
Variety				
KLB-320	108964	53755	55209	1.97
KLS-218	113162	57953	55209	2.05
SE(m) ±	2569.73	3008.65	---	0.031
C.D. (P=0.05)	NS	NS	---	NS
Weed Control				
Weedy	103145	47850	55295	1.87
Two hand weeding	119734	58225	61509	1.95
Pendimethalin@1kgai/ha	110391	54096	56295	1.96
SE(m) ±	3649.22	2912.67	---	0.041
C.D. (P=0.05)	10941.672	8733.248	---	0.0123

Cost of cultivation

Cost of cultivation is calculated by the adding the cost of input of common as well as variable inputs and have been table-7.

Gross income

Gross income was calculated by multiplying the market price prevailing at the time of harvest to grain yield and by product obtained from the different plot of the experiment and the data of gross income under the different used control treatment.

The data pertaining to gross income of lentil as affected by various weed management practices have been depicted in table-7. The perusal of data revealed that gross income was affected by tillage, variety and weed management practices. It was observed that gross income was not significantly affected by tillage and varieties. In weed control practices the significantly maximum gross income (119735 Rs./ha) was recorded where hand weeding twice (30 and 45 days after sowing) followed by under application of pendimethalin @ 1.0 kg ai/ha and significantly minimum gross income was observed in weedy check plot.

Net income

The data pertaining to net income of lentil as depicted table-7. The perusal of data revealed that net income was significantly affected by tillage practices. It was observed that numerically higher net income recorded under the conventional tillage. Between varieties non- significantly higher net income was recorded under the variety of KLS-218. Among the weed management practices the higher net income (65075 Rs./ha) was recorded under two hand weeding at 30 and 45 days after sowing followed by when applied pendimethalin @ 1.0 kg ai/ha and significantly minimum net income was calculated under the weedy check plot.

B:C Ratio

The data depicted in table-7. The perusals of data shows that B:C ratio was significantly affected by tillage, variety and weed management practices. It was observed that numerically higher B:C ratio was recorded under the conventional tillage. Between the varieties non-significantly higher B:C ratio was recorded under the variety of KLS-218. Among weed management practices the higher B:C ratio was recorded under two hand weeding at 30 and 45 days after sowing followed by application of pendimethalin @ 1.0 kg ai/ha and significantly minimum B:C ratio was observed under the weedy check plot.

Summary and Conclusion

The observations recorded on crop were final plant population, plant height and number of branches/plant at 90 days after sowing and number of pods/plant, number of grains/plant, 1000 grain weight, grain and straw yield and protein content in grains. Harvest index were also calculated. To find out the feasibility of weed control practices. Among varieties high yielding and dense growing with profuse branching with higher number of pods should be adopted to over-come weed menace in lentil crops. Among weed control practices two hand weeding at 30 and 45 DAS found to be most effective in controlling weeds in lentil crop to get maximum net return. Conventional tillage shows great response in terms of weed control as well as yield and net return. Farmer's' can adopt these practices for weed management in lentil crops

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