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Original Research Article

Effect of Integrated Weed Management Practices on Weed Dynamics, Yield and Economics in Lentil (*Lens culinaris* Medik.)

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A B S T R A C T

A field experiment was conducted during *rabi* season of 2006-2007 at Crop Research Centre of Sardar Vallabh Bhai Patel University of Agriculture and Technology, Meerut (U.P.) to find out the effect of integrated weed management practices on weed dynamics, yield and economics in lentil. The experiment consisted of ten integrated weed management treatments laid out in randomized block design replicated thrice. Results indicated that application of quizalofop-ethyle @ 50 g a.i. ha^{-1} POE *fb* one hand weeding at 45 days after sowing caused significant reduction in weed density and weed dry matter as compared to other treatments next to weed free. At harvest, highest plant height was recorded in 25 per cent higher seed rate which was significantly higher than all other treatments. Weed free produced significantly higher dry matter over remaining treatments, which was followed by quizalofop-ethyle @ 50 g a.i. ha^{-1} POE *fb* one hand weeding at 45 days after sowing. Maximum number of pods per plant was recorded in weed free. Differences in test weight owing to weed management treatments were non-significant. Weed free produced highest grain yield which was at par with quizalofop- ethyle @ 50 g a.i. ha^{-1} POE *fb* one hand weeding at 45 days after sowing and 25% higher seed rate *fb* one hand weeding at 30 days after sowing. These treatments increased the yield of lentil to the tune of 80, 72 and 67 per cent, respectively over weedy check. Highest net return (Rs. 27870 ha^{-1}) was observed with weed free. Next in order was quizalofop- ethyle @ 50 g a.i. ha^{-1} POE *fb* one hand weeding at 45 days after sowing. Highest B: C ratio (2.53) was noted with quizalofop- ethyle @ 50 g a.i. ha^{-1} POE *fb* one hand weeding at 45 days after sowing.

Keywords

Herbicides, Integrated Weed Management, Lentil and Seed rate

Introduction

Lentil, being the second important *rabi* pulse crop of India, occupies 1.44 million hectares of land and produced 1.05 million tonnes of grain annually at an average productivity of 732 kg ha^{-1} (Anonymous, 2005). At the global level though India's share in lentil production is quite large (30%), yet the productivity level is substantially low. Low productivity is the cumulative effect of several factors. Weeds alone cause the reduction in the yield to the tune of 84 per cent (Mohamed *et al.*, 1997).

The extent of loss generally depends upon the nature of crop, the weed species, weed density, duration and stage of competition with crop and time of weed removal. In order to harness the yield of any genotype, it is necessary to provide it a congenial weed free environment to a certain stage.

Among the various methods of weed control, hand weeding at frequent interval is uncomfortable and accomplishes the job effectively since it is quite expensive, pain staking as well as, the lack of availability of labour in peak season for timely control of weeds provides an opportunity to explore the other potential alternative method that can give the maximum yield with minimum investment. Several chemicals have been tried to control weeds in lentil in recent past. Moreover, continuous use of limited recommended herbicide may cause environmental pollution and weeds may develop resistant against these chemicals. Increasing plant density at crop weed competition period may increase the competitiveness in favour of the crop plant and reduce the ill effects of weeds. However, increasing population density may further result in declining yield due to increased competition among crop plant themselves.

It is, therefore, necessary to utilize more than one method of weed control for sustaining the productivity and ecosystem. Considering the above issues in mind, the present investigation was carried out to evaluate the effect of integrated weed management (IWM) on weed dynamics, yield of lentil and economics.

Materials and Methods

The field experiment was conducted at Crop Research Centre of Sardar Vallabh Bhai Patel University of Agriculture and Technology, Meerut (U.P.) in 2006-2007 during *rabi* season. Lentil used in the experiment was laid out in randomized block design with three replications with ten treatments namely weedy check (T_1), Weed free (T_2), One hand weeding at 30 days after sowing (T_3), Pendimethalin @ 1.0 kg a.i. ha^{-1} PE (T_4), Pendimethalin @ 1.0 kg a.i. ha^{-1} PE *fb* one hand weeding at 30 days after sowing (T_5), Pendimethalin @ 1.0 kg a.i. ha^{-1} PE *fb* Quizalofop-ethyle @ 50 g a.i. ha^{-1} POE (T_6), Quazalofop-ethyle @ 50 g a.i. ha^{-1} POE (T_7), Quazalofop-ethyle @ 50 g a.i. ha^{-1} POE *fb* one hand weeding at 50 DAS (T_8), 25% higher seed rate (T_9) and 25% higher seed rate *fb* one hand weeding at 30 days after sowing (T_{10}). Herbicidal treatments were sprayed after sowing of seed with hand knapsack sprayer.

Lentil crop was fertilized with recommended NPK at the time of last ploughing. Excluding weed management practice, all the recommended improved package of practices of lentil was followed in this experiment including general plant protection measures. Weed samples were collected using 50 cm x 50cm quadrate from randomly selected two places from each plot at 30, 60, 90 days after sowing and harvest stage.

Density and dry matter of weeds were recorded at these stages. Growth, yield attributes and yield of lentil were recorded at harvest stage of the crop and finally the economics was worked out in terms of cost of cultivation, net return and B: C ratio.

Data recorded on above parameters were subjected to their statistical analysis using design tested by 'F' test at 5 per cent level of significance and weeds data were transformed using square root (x+1) transformation and analysed (Cochran and Cox, 1959).

Results and Discussion

Effect of herbicides on weed density

Weed density increased up to 60 days stage of crop growth and thereafter, started declining. Maximum weed density was associated with weedy check at all the stages of crop growth.

At 30 days stage, significant reduction in weed population was recorded in all the chemically treated plots as compared to weedy check and other treatments. There was no significant difference in weed density among the pre-emergence and post-emergence herbicide treatments. Increasing seed rate by 25 per cent had no significant reduction in weed density as compared to weedy check at all crop growth stages.

At 60 days stage, significant reduction in weed density was recorded in all the treated plots as compared to weedy check (T_1) except 25 per cent higher seed rate (T_9). Quazalofop @ 50 g a.i. ha^{-1} POE *fb* one hand weeding at 45 DAS (T_8) recorded maximum reduction in total weed population next to weed free (T_2) and was significantly superior to remaining treatments except pendimethalin @ 1.0 kg a.i. ha^{-1} PE *fb* one hand weeding at 30 DAS (T_5). Treatments having one hand weeding either alone or in combination with chemical caused significant reduction in weed density than other treatments except weed free (T_2).

At 90 days stage, significant reduction in weed density was recorded in all the treatments, except 25 per cent higher seed rate (T_9) as compared with weedy check (T_9). One hand weeding done either at 30 or 45 days stage of crop growth in combination with herbicide (T_5 and T_8) excluding weed free (T_2) had significant reduction in weed density than other treatments. Quazalofop-ethyle @ 50 g a.i. ha^{-1} POE *fb* one hand weeding at 45 DAS (T_8) caused significant reduction in weed density next to weed free (T_2) and was significantly superior to remaining treatments except pendimethalin @ 1.0 kg a.i. ha^{-1} PE *fb* one hand weeding at 30 DAS (T_5). At harvest stage, Quazalofop-ethyle @ 50 g a.i. ha^{-1} POE *fb* one hand weeding at 45 DAS (T_8) caused significant reduction in weed density as compared to other treatments excluding weed free (T_2).

The weed control treatments reduced the population density of *Chenopodium album*, *Convolvulus arvensis* and other weeds as well as total weeds significantly except 25 per cent higher seed rate at all stages of crop growth as compared to weedy cheek (Table 1). High weed density under 25 per cent higher seed rate might be due to initial slow growth of the crop canopy which provides sufficient space for the weeds to grow. The weeds once established were able to compete with crop at later stages. Pendimethalin controlled the weeds more effectively than quizalofop- ethyle because of its high potential of weed control but when applied with the combination of one hand weeding at 30 and 45 days after sowing with pendimethalin and quizalofop-ethyle resulted better yield than pendimethalin. The other weed control treatments were able to reduce weed population either by destruction of weeds or by creating unfavourable condition of weed growth.

Smothering effect of crop on late germinated weeds have also been reported by Mani and Gautam (1997) and Farroda and Singh (1981). The reduction in weed dry weight (Table 1) and good weed control efficiency under all the treatments over weedy check (T_1) was due to reduction in weed density and individual dry weight of weeds reducing growth.

The highest total weed density in weedy check plot was observed at 60 days stage which reduced subsequently till harvest (Table 1). This revealed that majority of weeds emerged before 60 days stage and after that with increase in competition among weeds themselves and with the crop plants, there was reduction in weed density.

The low population of *Chenopodium album* and *Convolvulus arvensis* in later stage as a result of drying during subsequent growing period of crop decide all the chemical, manual and cultural weed control treatments were able to check increasing weed population. Similar results were also obtained by Jaswani and Baldev (1988).

Effect of herbicides on weed dry matter

Total dry matter of weeds increased consistently with the advancement in crop age up to 90 days stage and then decreased at harvest in weedy cheek (T_1) (Table 1). Differences in total dry matter of weeds recorded significant due to various treatments at all the stages of crop growth as compared to weedy cheek. Pendimethalin @ 1.0 g a.i. ha^{-1} PE (T_5) alone and with combination of quizalofop- ethyle @ 50 g a.i. ha^{-1} POE (T_6) significantly reduced dry matter of weeds as compared to remaining treatments except weed free (T_2).

At 30 days stage of crop growth, pendimethalin @ 1.0 kg a.i. ha^{-1} PE (T_5) reduced the total dry matter of weeds significantly than post–emergence application of quizalofop-ethyle @ 50 g a.i. ha^{-1} POE (T_7). Treatments having no chemical application were at par with weedy check (T_1) except weed free (T_2) could be visualised at 30 days stage.

At 60, 90 days and at harvest stage, all treatments significantly reduced total dry matter of weeds over weedy cheek (T_1) except 25 per cent higher seed rate (T_9). At 90 DAS and at harvest stage of crop growth, application of quizalofop-ethyle @ 50 g a.i. ha^{-1} POE *fb* one hand weeding at 45 days (T_8) recorded lower dry matter of weeds next to weed free (T_2) and was significantly superior to remaining treatments except pendimethalin @ 1.0 kg a.i. ha^{-1} PE *fb* one hand weeding at 30 DAS (T_5) and 25 per cent higher seed rate *fb* one hand weeding at 30 DAS (T_{10}).

The highest dry matter of weeds in weedy check plot (T_1) occurred at 90 days after sowing, although the highest weed population was observed at 60 days stage. This indicated that the crop weed competition would have been intensified after 60 days to reduce weed population, but the increase in dry matter of weeds up to 90 days after sowing might be due to higher dry matter accumulation by individual weed plant. The decrease in dry matter of weeds after 90 days stage was due to decrease total weed population (Table 1) as well as decrease individual dry weight as a result of leaf fall, shedding of seeds, drying of weeds etc.

Effect of herbicides on growth parameters

Plant height was influenced significantly by all the treatments at harvest stage. The highest plant height was recorded in 25 per cent higher seed rate (T_9) treatment at harvest stage which was significantly higher than that of all other treatments. At harvest stage, weed free treatment (T_2) produced significantly higher dry matter over remaining treatments, followed by quizalofop-ethyle @ 50 g a.i. ha^{-1} POE *fb* one hand weeding at 45 DAS (T_8) whereas 25 per cent higher seed rate recorded lowest dry matter production.

Table.1 Effect of different treatments on weed density and weed dry matter at various growth stages of lentil

Treatments	Weed density (No./ 0.25 m^2)				Weed dry matter (No./ 0.25 m^2)			
	30 DAS	60 DAS	90 DAS	Harvest	30 DAS	60 DAS	90 DAS	Harvest
T_1- Weedy check	7.37 (53.33)	7.63 (58.00)	6.68 (43.60)	4.72 (21.30)	2.60 (5.78)	3.84 (13.82)	4.70 (21.13)	4.07 (15.72)
T_2- Weed free	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
T_3- One hand weeding at 30 days after sowing	6.33 (39.70)	3.76 (13.30)	3.39 (10.70)	2.56 (5.70)	2.56 (5.62)	1.50 (1.27)	2.65 (6.12)	2.19 (4.03)
T_4- Pendimethalin @ 1.0 kg a.i. ha^{-1} PE	4.28 (17.30)	4.84 (22.70)	4.67 (21.00)	3.12 (9.00)	1.99 (2.98)	2.55 (5.52)	3.28 (10.21)	2.89 (7.54)
T_5- Pendimethalin @ 1.0 kg a.i. ha^{-1} PE *fb* One hand weeding at 30 days after sowing	4.35 (18.00)	3.09 (8.70)	3.02 (8.30)	2.50 (5.30)	2.00 (3.02)	1.31 (0.72)	1.76 (2.14)	1.58 (1.52)
T_6- Pendimethalin @ 1.0 kg a.i. ha^{-1} PE *fb* Quizalofop-ethyle @ 50 g ai ha^{-1} POE	4.03 (15.3)	4.50 (19.30)	3.91 (14.30)	3.36 (10.70)	1.96 (2.87)	2.02 (3.08)	2.80 (6.87)	2.19 (3.92)
T_7- Quizalofop-ethyle @ 50 g ai ha^{-1} POE	4.96 (23.70)	5.43 (29.00)	4.64 (20.70)	4.19 (16.70)	2.35 (4.52)	2.87 (7.36)	3.50 (11.27)	3.06 (8.35)
T_8- Quizalofop-ethyle @ 50 g ai ha^{-1} POE *fb* One hand weeding at 45 days after sowing	4.70 (21.30)	2.55 (6.00)	2.23 (4.30)	1.75 (2.70)	2.31 (4.37)	1.11 (0.23)	1.56 (1.52)	1.37 (1.02)
T_9- 25% higher seed rate	6.89 (46.70)	7.32 (52.70)	6.47 (41.00)	4.53 (19.70)	2.41 (4.84)	3.45 (10.96)	4.18 (16.53)	3.52 (11.42)
T_{10}- 25% higher seed rate *fb* One hand weeding at 30 days after sowing	6.53 (41.7)	3.91 (14.30)	3.15 (9.40)	2.64 (6.00)	2.42 (4.88)	1.38 (0.92)	1.99 (3.09)	1.69 (1.86)
SEm±	0.27	0.28	0.30	0.23	0.10	0.11	0.20	0.20
CD (P=0.05)	0.82	0.83	0.89	0.69	0.30	0.33	0.61	0.60

Table.2 Effect of different treatments on growth and yield attributes of lentil

Treatments	Plant height (cm)	Dry matter accumulation (g/plant)	Pods/plant	Grains/pod	Test weight (g)
T_1- Weedy check	32.1	6.04	65.3	1.57	15.28
T_2- Weed free	35.4	11.80	82.3	2.00	16.63
T_3- One hand weeding at 30 days after sowing	33.9	8.92	76.0	1.77	16.52
T_4- Pendimethalin @ 1.0 kg a.i. ha^{-1} PE	34.1	8.03	75.3	1.73	15.84
T_5- Pendimethalin @ 1.0 kg a.i. ha^{-1} PE *fb* One hand weeding at 30 days after sowing	34.5	9.15	77.4	1.80	16.37
T_6- Pendimethalin @ 1.0 kg a.i. ha^{-1} PE *fb* Quizalofop-ethyle @ 50 g ai ha^{-1} POE	33.2	7.91	70.4	1.70	16.08
T_7- Quizalofop-ethyle @ 50 g ai ha^{-1} POE	32.6	7.04	69.5	1.73	15.77
T_8- Quizalofop-ethyle @ 50 g ai ha^{-1} POE *fb* One hand weeding at 45 days after sowing	35.1	9.51	80.2	1.83	16.45
T_9- 25% higher seed rate	44.5	5.35	62.9	1.50	15.98
T_{10}- 25% higher seed rate *fb* One hand weeding at 30 days after sowing	38.9	6.69	71.5	1.67	16.42
SEm±	1.80	0.648	2.2	0.08	0.42
CD (P=0.05)	5.39	1.940	6.6	0.26	NS

Table.3 Effect of different treatments on yield and economics of lentil

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index (%)	Cost of cultivation (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B:C ratio
T_1- Weedy check	861	1742	33.08	8779	13607	1.55
T_2- Weed free	1552	2954	34.45	12482	27870	2.23
T_3- One hand weeding at 30 days after sowing	1302	2424	34.95	10009	23843	3.38
T_4- Pendimethalin @ 1.0 kg a.i. ha^{-1} PE	1232	2253	35.32	10388	21644	2.08
T_5- Pendimethalin @ 1.0 kg a.i. ha^{-1} PE *fb* One hand weeding at 30 days after sowing	1382	2494	35.65	11003	24929	2.26
T_6- Pendimethalin @ 1.0 kg a.i. ha^{-1} PE *fb* Quizalofop-ethyle @ 50 g ai ha^{-1} POE	1062	1927	35.54	11925	15687	1.31
T_7- Quizalofop-ethyle @ 50 g ai ha^{-1} POE	1002	1884	34.74	10316	15736	1.53
T_8- Quizalofop-ethyle @ 50 g ai ha^{-1} POE *fb* One hand weeding at 45 days after sowing	1488	2698	35.55	10931	27757	2.53
T_9- 25% higher seed rate	1052	2067	33.80	9309	18043	1.94
T_{10}- 25% higher seed rate *fb* One hand weeding at 30 days after sowing	1442	2775	34.21	10846	26646	2.46
SEm±	40.27	92.42	0.39			
CD (P=0.05)	120.57	276.73	1.19			

Dry matter accumulation per plant is an ultimate result of all the metabolic processes occurring inside the plant. The higher value of total dry matter per plant under above treatments might be due to higher photosynthetic organs (Table 2). In addition, lower weed density and dry matter under above treatments might have created congenial environment for crop growth and development which led to more accumulation of dry matter for plant.

Effect of herbicides on yield attributing characters

The maximum number of pods per plant was recorded in weed free (T_2) whereas the treatment having 25 per cent higher seed rate (T_9) recorded significantly lower number of pods per plants than remaining treatments (Table 2). All the alone herbicidal treatments recorded somewhat identical number of pods per plant and were significantly superior to 25 per cent higher seed rate (T_9) and did not differ significantly among themselves. Higher pods per plant under these treatments might be due to higher number of branches per plant, higher dry matter accumulation per plant and less competition between crop plant and weeds.

The maximum number of grains per pod was recorded in case of weed free (T_2) which was statistically at par with all chemical treatments along with one hand weeding (T_5 and T_8). All chemically

treatments did not differ significantly with each other with respect to number of grains per pod. More number of grains might be due to more number of leaves per plant (source) providing larger source for photosynthesis. Moreover, due to less weed competition, crop plant might have got ample space for spreading their source (leaves) which trapped solar radiation more efficiently than remaining treatments. More number of leaves (source) at grain filling stage provided more transfer of nutrients to sink which might be responsible for more grains for pod. More dry matter accumulation in sink due to larger source had also been recorded by Gardner *et al.*, (1985).

Differences in test weight due to different weed control treatments were non-significant. Weed free treatment produced relatively higher test weight, however, weedy check treatment (T_1) recorded the lowest test weight among all the treatments (Table 2).

Effect of herbicides on yield of lentil

Grain yield of lentil differed significantly due to different weed control treatments. Weed free (T_2) treatment produced highest grain yield which was at par with quizalofop- ethyle @ 50 g a.i. ha^{-1} POE *fb* one hand weeding at 45 DAS (T_8) and 25 per cent higher seed rate *fb* one hand weeding at 30 DAS (T_{10}) out yielded remaining treatments (Table 3). These treatments increased the yield to the tune of 80, 72 and 67 per cent, respectively over weedy cheek (T_1) which produced lowest grain yield. Grain yield is cumulative effect of plant population and grain yield per plant. Higher grain yield under these treatments might be attributed to higher plant density and higher grain yield per plant. Higher grain yield per plant might be the result of more number of pods per plant and grains per pod and better crop growth in term of dry matter accumulation at different stages as well as higher harvest index and higher uptake of nutrients (N, P &K) by crop.

Kumar and Kolar (1989) also reported that superior response of lentil to hand weeding in comparison to alone herbicide application. Singh *et al.*, (1983) also observed at par yield in higher seed rate with mechanical weeding. Increase in grain yield by hand weeding were also reported by Singh and Choudhary (1970), Mani and Gautam (1977), Ahlawat *et al.*, (1979), Chaudhary and Singh (1987), Turk and Tawaha (2002) and Elkoca *et al.*, (2005). Higher grain yield under these treatments might be due to more number of pods. Higher yield attributing characters (pods per plant and grains per pod) increased yield of lentil were also observed by Venkateswarulu (1984).

Weed free (T_2) produced significantly higher straw yield over remaining treatments except quizalofop-ethyle @ 50 g a.i. ha^{-1} POE *fb* one hand weeding at 45 DAS (T_8) and 25 per cent higher seed rate *fb* one hand weeding at 30 DAS (T_{10}). The effect of weed control treatment on straw yield differed significantly.

Effect of herbicides on harvest index

Differences in harvest index computed under all treatments statistically at par with weed free (T_2) except weedy check (T_1). Pendimethalin @ 1.0 kg a.i. ha^{-1} *fb* one hand weeding at 30 DAS (T_5) recorded the highest harvest index whereas weedy check (T_1) and 25 per cent higher seed rate (T_9) recorded the lowest value (Table 3). All the weed control treatments recorded highest harvest index over weedy check (T_1), except 25 per cent higher seed rate (Table 3). The

harvest index speaks of the conversion efficiency of non-grain portion by turning up nutrients as well as utilization. Lower straw yield in proportion to grain associated under above treatment increased harvest index (Table 3), more number of leaves at grain filling stage might have yielded more photosynthates and transfer to pods and grains.

Effect of herbicides on economics

The data given in Table 3 indicated that highest cost of cultivation (Rs. 12482 ha^{-1}) was observed in weed free plot due to large requirement of man labour which was very uneconomical. Among the treatments, the lowest cost of cultivation was observed with 25 per cent higher seed rate (Rs. 9309 ha^{-1}) after weedy check (T_1).

The highest net return (Rs. 27870 ha^{-1}) was observed with weed free (T_2) and the cost of cultivation was higher as compared to other treatments. Next in order were quizalofop-ethyle @ 50 g a.i. ha^{-1} POE *fb* one hand weeding at 45 DAS (Rs. 27757 ha^{-1}) and 25 per cent higher seed rate *fb* one hand weeding at 30 DAS (Rs. 26646 ha^{-1}).

The data cited in Table 3 inferred that highest B: C ratio (2.53) was obtained with quizalofop- ethyle @ 50 g a.i. ha^{-1} POE *fb* one hand weeding at 45 DAS (T_8) which was at par with 25 per cent higher seed rate *fb* one hand weeding at 30 DAS (T_{10}) and one hand weeding at 30 DAS (T_3). Whereas lowest in weedy check and pendimethalin @ 1.0 kg a.i. ha^{-1} PE *fb* quizalofop-ethyle @ 50 g a.i. ha^{-1} POE. Despite higher yield, weed free condition (T_2) could not give highest benefit: cost ratio as it required huge expense on labour towards control of weeds. This is obvious from cost of cultivation which was highest in weed free. Weed free condition throughout the crop period has also been reported uneconomical by Turk and Tawaha (2001).

Hence, it might be concluded that post emergence application of quizalofop-ethyle @ 50 g a.i. ha^{-1} *fb* one hand weeding at 45 days after sowing can control weeds effectively in lentil and resulted in highest yield, net return and B:C ratio. This treatment was followed by 25 per cent higher seed rate *fb* one hand weeding at 30 days after sowing in controlling weeds, improving yield of lentil as well as economic profitability.

References

Ahlawat, I.P.S.; Singh, A. and Saraf, C.S. 1979. Studies on weed control in lentil. LENS 6 (2): 19-21.

Anonymous, 2005. Net Availability of food grain (per day) in India from 1951 to 2004. Agricultural statistics at a glance. 158p.

Chaudhary, M. and Singh, T.P. 1987. Studies on weed control in lentil. *Indian Journal of Agronomy* 32 (3): 295-297.

Elkoca, E.; Kantar, F and Zengn, H. 2005. Weed control in lentil (*Lens culinaris*) in eastern Turkey. *New-Zealand Journal of Crop and Horticulture Science* 33 (3): 223-231.

Faroda, A.S. and Singh, R.C. 1981. Weed control in pulses. Pulse Crops Newsletter. 1 (2): 50-51

Gardner, F.P., Pearce, R.B. and Mitchell, R.L. 1985. Physiology of crop plants. Second Edition. Scientific Publisher, Jodhpur. p 58-76.

Jaswani, L.M. and Baldev, B. 1988. Advances in pulses production technology. I.C.A.R. p. 78.

Kumar, K. and Kolar, J.S. 1989. Effect of chemical weed control and *Rhizobium* inoculation on the yield of lentil.

Journal of Research P.A.U., Ludhiana 26 (1): 19-24.

Mani, V.S. and Gautam, K.C. 1977. Crop production in relation to critical period of weed competition. In program and Abstract of papers. Weed Science Conference and Workshop in India, paper no. 108, 65.

Mohamad, E.S.; Noural,A.H,; Mohamad, M.I. and Saxena, M.C. 1997. Weed and weed management in irrigated lentil in northen Sudan. Weed Research oxford. 37 (4): 211-218.

Singh, N.P.; Singh, H.P.; Sahu, J.P. and Sharma, B.B. 1983. Weed management in lentil. Annual Report of research, 1983. G.B.P.U.A. & T., Pantnagar (Nainital).

Singh, R. and Chaudhary, S.L. 1970. A note on weed control in *rabi* pulses with pre-emergence and pre-planting herbicides. *Indian Journal of Agronomy* 15 (3): 302-304.

Turk, M.A. and Tawaha, A.M. 2001. Lentil (*Lens culinaris* Medik) response to frequencies of hand weeding. *Indian Journal of Agricultural Research* 36 (2): 137-140.

Turk, M.A. and Tawaha, A.M. 2002. Effect of time and frequency of weeding on growth, yield and economics of chickpea and lentil. *Research on Crops* 2 (2): 103-107.

Venkateswarulu, E. 1984. Studies on weed control in lentil. M.Sc. (Ag.) Thesis submitted to G.B.P.U.A.& T., Pantnagar. p. 57-63, 65-74 and 80.