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Impact of Weed Management Practices on Growth and Yield of Lentil (*Lens culinaris* L.)

[1]Priyanka Bankoti; [2]Mansi Nautiyal

[1]Associate Professor, School of Agricultural Sciences, Shri Guru Ram Rai University, Dehradun, U.K-248001
[2]Ph.D. Scholar, School of Agricultural Sciences, Shri Guru Ram Rai University, Dehradun, U.K-248001
[1] priyankabankoti28@gmail.com; [2] mansinautiyal94@gmail.com

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Abstract: ***An investigation was conducted on agriculture research farm, School of Agricultural Sciences, SGRRU in Dehradun district to evaluate the different weed management practices on growth and yield of lentil during the Rabi season of 2018-2019-with four replications and nine treatments to investigate the impact of manual, herbicidal and integrated treatments. The treatments constituents quizalofop ethyl @ 55gm, ha as PE, imazethapyr @ 37gm/ha as PE, Chlorimuran ethyl @ 4.5 gm/ha as PPI, pendimethalin @ 1.5 kg as PE, Pendimethalin + Imazethapyr (ready – mix) @ 0.20 kg /ha, Pendimethalin + Imazethapyr (ready – mix) @ 1.5 kg a.i/ha as PE, Pendimethalin @ 1.5 kg/ha as PE + Hand weeding at 40 DAS, Hand weeding thrice at 35, 65 and 90 DAS and control plot. The highest grain and straw yield were recorded 1865 kg/ha and 3099 kg/ha respectively during T8 treatment and the lowest 1380 kg/ha and 2582 kg/ha of grain and star yield was recorded during T3 treatment. The prominent weeds found in the experimental plot were Cannabis sativa, Cynodon dactylon, Chenpodium album and Parthenium hysterophorus: and these weeds together consituted 57 percent of the total weed population.***

Keywords: Lentil, integrated, herbicidal, weed, grain.

1. INTRODUCTION

Lentil (*lens culinaris* L.) belongs to family Fabaceae is one of the most important legume crops of all over the world. In India, lentil is mostly grown in northern plains, central and eastern parts of the country. The major lentil producing states are Madhya Pradesh, Uttar Pradesh, Bihar, Uttarakhand and Bengal. It is an important Rabi pulse crop next to gram. It is the first one of the food crops to have been cultivated and maintained excellent socio-economic value for 8000 years. It is mainly grown for its edible seed which matures between 90 to 120 days and popularly known as 'Masoor' in India (Taylor P.K *et al*., 2007).The nutrient value of lentil composed of 60% of carbohydrates, 26% of protein, 7.5% of iron, 20% of sugars and 0.87% of thiamine (Vitamin B1), which make it very essential in human and animal feeding where the stubble is also very rich in many valuable components (Sharara *et al.,* 2011).Lentil is an herbaceous annual plant mostly erect and bushy type with 4 – 6 primary branches. Lentil is well developed root system including a central tap root with several lateral branches spread out in all directions. The stem is weak and quadrangular. The leaves are small compound and pinnate. The end of leaflets sometimes forms tendrils. The inflorescence is a raceme of 2 – 4 flowers. Flowers are small, white tinged and blue violet or pink. The pods are oblong, slightly inflated and about 1.5 cm long, each of them contains two seeds, about 0.5 cm in diameter. In the Characteristics lens shape flowering in lentil plant takes about two weeks on the single branch and then opens after two three days of the opening of the flowers. The colour begins to lighten not complete closing followed by setting of the pods after three to four days (Shyam *et al.,* 2007). Lentil requires a cold climate. Hence it is sown as a winter/Rabi season crop. It can be raised successfully up to a height of 3000 m. Unlike gram, it remains unaffected by rain at any stage of its growth including flowering and fruiting. It is very hardy plant and can tolerate frost and severe winter to a great extent. The optimum temperature for growth is 18 – 30 0C. Weed control in lentils is important as this crop is a poor competitor due to its short height and slow early growth. Lentil's low competitive ability is compounded when growing season temperatures are low or when moisture is scarce. Herbicides are very attractive in lentil due to increased cost of manual weeding, its poor efficiency and non-availability during critical periods. Herbicides are very attractive in lentil due to increased cost of manual weeding, its poor efficiency and non-availability during critical periods. Herbicides have revolutionized agriculture all over the world and have played key roles in enhancing productivity. They are accepted as an essential tool in weed management as they reduce labour requirement enormously and are easy and convenient to use (Rao and Nagamani, 2010). Hand weeding becomes difficult because of problems in differentiating grassy weeds, labour scarcity, and time consuming and costly. Timely weed control can normally be achieved by employing two hand weeding's within the specified period, on small scale farms. This practice is, however, difficult to achieve and uneconomical on large scale farms due to the exorbitant cost of labour, the slowness of the operation, the uncertainty of the availability of labour when needed and the drudgery involved in the practice (Fadayomi and Olofintoye, 2005).

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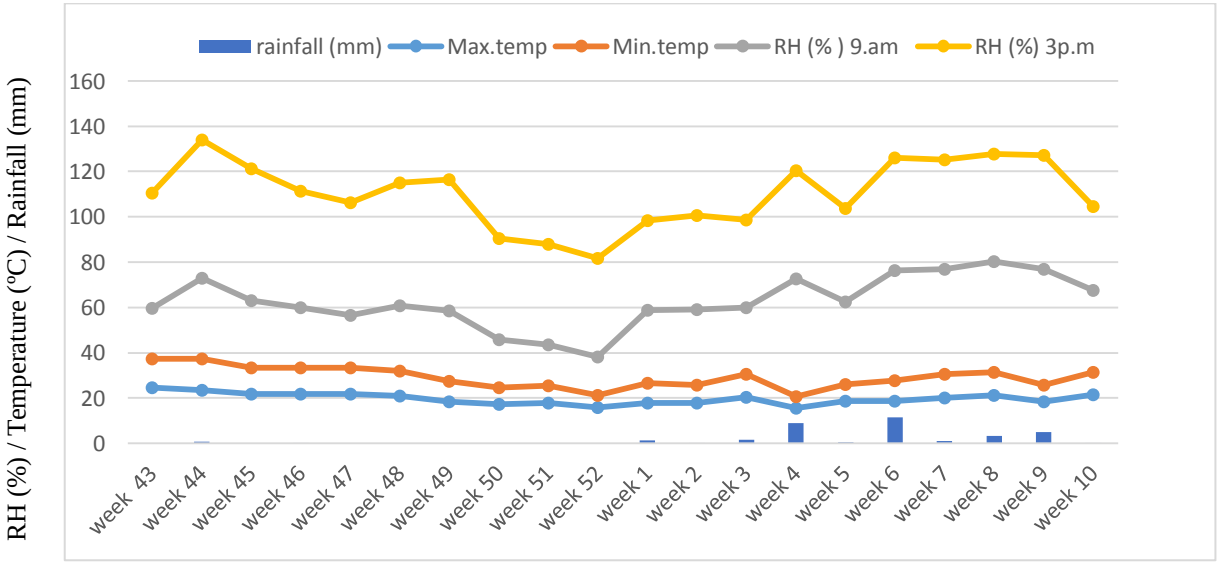
2. MATERIALS AND METHODS

The field experiment was conducted during Rabi season of 2018–19 in the agriculture research farm of School of Agricultural Sciences of SGRRU, Dehradun, Uttarakhand. The common weeds observed in lentil fields were *Chenopodium album* L., *Parthenium hysterophorus* L., *Cannabis sativa* L., *Cyperus rotundus* L., *Cynodon dactylon* L. There were nine treatments consisting of weed management practices Treatments list and their symbol is given in Table 1. The experiment was laid out in a randomized block design (RBD) with four replications. The plot size was 15 m^2 (5.00 x 3.00 m^2) Sowing was carried out manually in rows 25 cm apart. The study area is situated in the north western region of Uttarakhand at an altitude of 450 m above mean sea level (MSL) and 3088 square kilometre in size. The climate of Dehradun is humid subtropical. Summer temperatures can reach up to 44°C for a few days and a hot wind called Loo blows over North India. Winter temperatures are usually between 1 and 20°C and fog is quite common in winters like plains. During the monsoon season, there is often heavy and protracted rainfall. Average Rainfall is 2074 mm. It was recorded that Dehradun received 1734 mm rainfall from the month of July to October in 2018. Meteorological observation during cropping period at the experimental site revealed the maximum and minimum temperature (i.e., October 2018 to March 2019) was 25ºC and 3ºC respectively (Fig. 1)

Table 1: The classified description of the treatments with corresponding symbols in order to facilitate their reference in the table is given below:

Symbols	Treatments
T_1	Quizalofap ethyl @ 55 gm /ha at 30 DAS (Post emergence).
T_2	Imazethapyr @ 37 g /ha at 30 DAS (Post emergence).
T_3	Chlorimuran ethyl @ 4.5 g /ha as (Pre plant incorporation).
T_4	Pendimethalin @ 1.5 kg /ha as (Pre emergence).
T_5	Pendimethalin + Imazethapyr (ready – mix) @ 0.20 kg /ha as (Pre emergence).
T_6	Pendimethalin + Imazethapyr (ready – mix) @ 1.5 kg /ha as (Pre emergence).
T_7	Pendimethalin @ 1.5 kg /ha as pre-emergence + Hand weeding at 40 DAS
T_8	Hand weeding thrice at 35, 65 and 90 DAS.
T_9	Weedy Check (Control plot).

Fig. 1 Weekly Meteorological data during the crop season (25th October, 2018 to 10th March 2019)



Source: ICAR- Indian Institute of Soil and Water Conservation, Dehradun, U.K

The lentil variety Pant L639 was grown with seed rate of 25 kg /ha and NPKS dose of 20:17:16:20 per hectare was applied to crop under rainfed condition during the year of experimentation. Pant L 639 is a medium maturing, semi – spreading variety having light green foliage. Seeds are medium sized and grey mottled. It is highly resistance to blight and milt diseases. Observations of yield and growth parameters like plant height (cm), no. of branches/plant, no. of pod/plant, no. of grain/pod, grain yield (q/ha) and straw yield (g) of maturity periods, and related to weed effect of lentil plot on weed count

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/m^2 and dry weight of weeds were taken at 35,65 and 90 DAS interval from the experimental plots from randomly selected area of 0.50 m x 0.50m. Harvest index (HI) % were calculated as per the standard formula as well as economics of lentil/ha. The soil of research site is classified as 'sandy loam' with characteristics as deep, well drained, coarse loamy cover over fragmental soils and of medium fertility. With PH of 7.12.

Chlorimuron ethyl

Used as post-emergence for control of important broad-leaved weeds, such as cocklebur, pigweed, sunflower and annual morning glory. Chlorimuron ethyl is a sulfonylurea class herbicide that inhibits acetolactate synthase, which regulates plant growth.

Quizalofop ethyl

Used as a selective post-emergence phenoxy herbicide. It is used to control annual and perennial grass weeds in potato, lentil, soyabean, sugar beet, peanut, vegetables, cotton and flax, as well as other crops. Good to excellent control of foxtail, volunteer corn and proso millet. Corn, shatter cane and wild proso millet are controlled at lower rates.

Pendimethalin

It is a selective herbicide used to control most annual grasses and certain broadleaf weeds in field corn, lentil, potato, rice, cotton, soyabean, tobacco, peanut and sunflower. It is used both pre-emergence as well as early post-emergence. Incorporated in soil by cultivation or irrigation is recommended within 7 days following application.

Imazethapyr

An herbicide of the Imidazoline group used as an early post-emergence herbicide to control selective broad-leaved and grassy weeds in soybean and groundnut.

3. RESULTS AND DISCUSSION

Effect on crop

The effect of herbicides on grain and straw yield of lentil was found significant (Table.2). Grain yield of treatment T_8 (hand weeding thrice) though recorded significantly highest grain yield (1865 kg/ha) but was found at par with T7 (1755 kg/ha). Similarly, T7 recorded similar grain yield to that of T6 (1619 kg/ha) and T4 (1595 kg/ha). No significant differences were observed between post-emergence weed control treatments like T2 (1520 kg/ha) and T1 (1465 kg/ha) and pre-emergence application of pendimethalin alone (1595 kg/ah) followed by pre-emergence application of pendimethalin + imazethapyr (ready – mix) at lower dose (1698 kg/ha). Among the weed control treatments, T3 (pre-plant incorporation of chlorimuron ethyl @ 4.5 g/ha) proved to be less effective which recorded lowest grain yield (1380 kg/ha) but was significantly higher than the weedy check (1105 kg/ha). Straw yield of treatments, T_8 produced significantly higher straw yield (3099 mg/ha) than other treatments. Further, treatment T_7 gave slightly higher straw yield (2712 kg/ha) closely followed by pre-emergence treatment like T_2 (2582 kg/ha) and T_1 (2546 kg/ha). Pre-plant incorporation of chlorimuron ethyl @ 4.5 g/ha (T_3) recorded lowest straw yield (2297 kg/ha) among the weed control treatments. Plant height at 35 days, T_7 recorded maximum plant height (4.70 cm), however and weedy check plots had minimum plant height (4.13 cm). Plant height at 65 days of crop growth, the maximum plant height was obtained under T_8 (11.13 cm. While the minimum plant height was observed under weedy check plots (8.78 cm). Plant height at 90 days stage, weedy check plots recorded significantly lower plant height (20.48 cm) than other weed control treatments. The maximum plant height (27.28 cm) was obtained under T_8 (hand weeding thrice). (Table.3). Plant branches at 35 DAS, T_7 recorded the maximum number of branches per plant (2.44), T_3 recorded the minimum number of branches per plant (2.13) which was almost equal to weedy check (2.21). At 65 days of crop growth, the maximum number of branches per plant was obtained under T_8 (6.30). Significantly lowest number of branches per plant was observed in weedy check plots (3.09). At 90 days of crop growth, the maximum number of branches per plant was obtained under T_8 (7.32). Significantly lowest number of branches per plant was observed in weedy check plots (5.58) (Table.4). The effect of weed control treatments on number of pods per plant was found significant. All the weed control treatments, except T_1 (45.78), T_2 (46.38), T_3 (45.18) and T_4 (48.23), recorded significantly higher number of pods per plant than weedy check. Weedy check recorded the lowest number of seeds per pod (1.31). Among the weed control treatments, T_8 recorded significantly highest number of seeds per pod (1.59), however, was found at par to T_7 (1.51) and T_6 (1.50) but significantly surpassed over rest of the treatments. (Table.5).

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Table 2: Yields of Lentil crop influenced by different treatments

Treatments		Grain Yield kg/ha	Straw Yield kg/ha	Harvest Index (%)
T_1	Quizalofop ethyl @ 55 g/ha as POE (30 DAS)	1465	2546	36.52
T_2	Imazethapyr @ 37 g/ha as POE (30 DAS)	1520	2582	37.05
T_3	Chlorimuron ethyl @ 4.5 g/ha as PPI	1380	2297	37.53
T_4	Pendimethalin @ 1.5 kg/ha as PE	1595	2613	37.9
T_5	Pendimethalin + Imazethapyr (ready mix) @ 0.20 kg/ha as PE	1618	2618	38.2
T_6	Pendimethalin + Imazethapyr (ready mix) @ 1.50 kg/ha as PE	1685	2676	38.63
T_7	Pendimethalin @ 1.5 kg/ha as PE + HW at 40 DAS	1755	2712	39.29
T_8	Hand weeding (HW) thrice at 35, 65 and 90 DAS	1865	3099	37.57
T_9	Weedy check (Control plot)	1105	1952	36.14
SEm±		13.57	35.516	0.434
CD (P = 0.05)		39.843	104.28	1.274

Table 3: Plant height (cm) at various stages of crop growth as influenced by different treatments.

Treatments		Days After Sowing		
		35	65	90
T_1	Quizalofop ethyl @ 55 g/ha as POE (30 DAS)	4.15	9.83	23.93
T_2	Imazethapyr @ 37 g/ha as POE (30 DAS)	4.16	9.88	24.18
T_3	Chlorimuron ethyl @ 4.5 g/ha as PPI	4.21	9.08	23.78
T_4	Pendimethalin @ 1.5 kg/ha as PE	4.53	10.13	24.73
T_5	Pendimethalin + Imazethapyr (ready mix) @ 0.20 kg/ha as PE	4.56	10.38	25.08
T_6	Pendimethalin + Imazethapyr (ready mix) @ 1.50 kg/ha as PE	4.64	10.63	25.28
T_7	Pendimethalin @ 1.5 kg/ha as PE + HW at 40 DAS	4.7	10.78	26.53
T_8	Hand weeding (HW) thrice at 35, 65 and 90 DAS	4.32	11.13	27.28
T_9	Weedy check (Control plot)	4.13	8.78	20.48
SEm±		0.051	0.087	1.237
CD (P = 0.05)		0.148	0.25	0.69

Table 4: Number of branches per plant at various stages of crop growth as affected by different treatments

Treatments		Days After Sowing		
		35	65	90
T_1	Quizalofop ethyl @ 55 g/ha as POE (30 DAS)	2.25	5.1	6.44
T_2	Imazethapyr @ 37 g/ha as POE (30 DAS)	2.29	5.39	6.51
T_3	Chlorimuron ethyl @ 4.5 g/ha as PPI	2.13	4.93	6.17
T_4	Pendimethalin @ 1.5 kg/ha as PE	2.33	5.56	6.95
T_5	Pendimethalin + Imazethapyr (ready mix) @ 0.20 kg/ha as PE	2.36	5.79	7.05
T_6	Pendimethalin + Imazethapyr (ready mix) @ 1.50 kg/ha as PE	2.39	6.11	7.18
T_7	Pendimethalin @ 1.5 kg/ha as PE + HW at 40 DAS	2.44	6.23	7.2
T_8	Hand weeding (HW) thrice at 35, 65 and 90 DAS	2.33	6.3	7.32
T_9	Weedy check (Control plot)	2.21	3.09	5.58
SEm±		0.028	0.059	0.065
CD (P = 0.05)		0.082	0.173	0.191

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Table 5: Yield attributing characters as affected by different treatments

Treatments		Number of Pods per Plant	Number of Seeds per Plants
T_1	Quizalofop ethyl @ 55 g/ha as POE (30 DAS)	45.78	1.43
T_2	Imazethapyr @ 37 g/ha as POE (30 DAS)	46.38	1.46
T_3	Chlorimuron ethyl @ 4.5 g/ha as PPI	45.18	1.42
T_4	Pendimethalin @ 1.5 kg/ha as PE	48.23	1.48
T_5	Pendimethalin + Imazethapyr (ready mix) @ 0.20 kg/ha as PE	53.83	1.49
T_6	Pendimethalin + Imazethapyr (ready mix) @ 1.50 kg/ha as PE	70.78	1.5
T_7	Pendimethalin @ 1.5 kg/ha as PE + HW at 40 DAS	74.63	1.51
T_8	Hand weeding (HW) thrice at 35, 65 and 90 DAS	98.43	1.59
T_9	Weedy check (Control plot)	42.33	1.31
SEm±		0.414	0.013
CD (P = 0.05)		1.216	0.038

Effect on weed

The application of herbicides significantly affected the weed characters like weed population (Table.6). and weed growth rate (Table.7). T_8 scored significantly minimum weed population (8.17/m^2) and T_1 recorded maximum weed population (17.34/m^2) weed population significantly over weedy check at 35 DAS of crop growth. At 65 days of crop growth, the maximum weed population was obtained under weedy check (21.85/m^2) as compared to other treatments and all the weed control treatments reduced the weed population significantly over weedy check. The treatment T_8 recorded significantly minimum weed population (9.60/m^2) and was statistically at par with T_7 (9.83/m^2) and T_2 (11.50/m^2). At 90 DAS stage, weedy check recorded significantly higher weed population (22.24/m^2) as compared to other weed control treatments. The minimum weed population was obtained with T_8 (9.62/m^2) and was almost similar to T_7 (10.06/m^2), T_2 (11.37/m^2), T_6 (11.65/m^2), T_5 (12.49/m^2) and T_1 (12.54/m^2). Weedy check plot recorded higher weed growth rate at all the three crop growth stages, *i.e.*, 35, 65 and 90 DAS and had significantly higher value than other treatments at all the stages of crop growth.

Table 6: Total weed population (No./m^2) as affected by various treatments

Treatments		Days After Sowing		
		35	65	90
T_1	Quizalofop ethyl @ 55 g/ha as POE (30 DAS)	17.33	12.11	12.54
T_2	Imazethapyr @ 37 g/ha as POE (30 DAS)	17.14	11.5	11.37
T_3	Chlorimuron ethyl @ 4.5 g/ha as PPI	14.11	14.65	15.24
T_4	Pendimethalin @ 1.5 kg/ha as PE	11.61	14.24	13.08
T_5	Pendimethalin + Imazethapyr (ready mix) @ 0.20 kg/ha as PE	11.86	14.3	12.49
T_6	Pendimethalin + Imazethapyr (ready mix) @ 1.50 kg/ha as PE	11.5	14.01	11.65
T_7	Pendimethalin @ 1.5 kg/ha as PE + HW at 40 DAS	11.52	9.83	10.06
T_8	Hand weeding (HW) thrice at 35, 65 and 90 DAS	8.17	9.6	9.62
T_9	Weedy check (Control plot)	18	21.85	22.24
SEm±		0.131	0.164	0.088
CD (P = 0.05)		0.384	0.482	0.258

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Table 7: Weed growth rate (g/day/m2) as affected by various treatments

Treatments		Days After Sowing		
		0 – 35	35 – 65	65 – 90
T_1	Quizalofop ethyl @ 55 g/ha as POE (30 DAS)	0.366	0.53	1.063
T_2	Imazethapyr @ 37 g/ha as POE (30 DAS)	0.373	0.22	0.899
T_3	Chlorimuron ethyl @ 4.5 g/ha as PPI	0.311	0.886	0.915
T_4	Pendimethalin @ 1.5 kg/ha as PE	0.25	0.787	0.443
T_5	Pendimethalin + Imazethapyr (ready mix) @ 0.20 kg/ha as PE	0.27	0.694	0.571
T_6	Pendimethalin + Imazethapyr (ready mix) @ 1.50 kg/ha as PE	0.238	0.683	0.487
T_7	Pendimethalin @ 1.5 kg/ha as PE + HW at 40 DAS	0.243	0.153	0.673
T_8	Hand weeding (HW) thrice at 35, 65 and 90 DAS	0.126	0.164	0.668
T_9	Weedy check (Control plot)	0.471	1.993	1.195
SEm±		0.003	0.01	0.027
CD (P = 0.05)		0.01	0.029	0.082

ECONOMICS OF PRODUCTION

All the weed control treatments registered significantly higher gross return over weedy check. The maximum gross return (` 88382) was obtained under treatment $T_8$ though was statistically at par with $T_7$ (` 83215) and T_6 (` 0333) but was significantly superior to the rest of the treatments in respect of gross return. All weed control treatments recorded significantly higher net return over control plot. Treatment $T_8$ although generated the highest net return (` 57723), however, was statistically at par with all the weed control treatments except T_1 (` 47348) and $T_3$ (` 44346). Both of these treatments (T_1 and T_3) significantly scored over weedy check (` 33091). Similar findings were also reported by Turk and Tawaha (2001) and Jain (2007).

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