A Research On Influence Of Different Weed Control Methodologies On Various Aspects Of Weed Control As Well As Nutrient Depletion Due To Various Weeds And Weed Control Techniques In The Crop Of Lentil (*Lens Culinaris* Medik.)

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Abstract:
A field experiment was conducted at the Crop Research Centre, School of Agriculture, Uttaranchal University, Dehradun, Uttarakhand to observe 'The efficiency of different weed management practices in Lentil' during the Rabi season of 2021-22. The experimental design used for the purpose was Randomised Block Design with 3 replications and 8 treatments. The treatments were as Control, 2 hand-weeding, Atrazine (Pre-emergence) @1kg a.i. /ha, Atrazine (PE) + 1 hand-weeding, Pendimethalin (post-emergence) @ 1kg a.i. /ha, Pendimethalin (PE) + 1 hand-weeding, Isoproturon (PoE) @ 1 kg a.i. /ha and Isoproturon (PoE) + 1hand-weeding. Out of the above treatments, Pendimethalin + 1 hand-weeding was most effective in controlling the weeds and attaining higher efficiency of weed control. The treatment of 2 hand-weeding was also equally efficient however it is not practical to be performed in larger areas. The treatment of Two hand-weeding observed the lowest nutrient depletion.

Keywords: Atrazine, Isoproturon, Pendimethalin, Weed biomass, Weed density, Weed control efficiency, Yield

INTRODUCTION

India, Canada, Australia, Turkey, United States of America, China, Nepal and Ethiopia are the prime producers in worldwide production of lentil (FAOSTAT). In 2020, worldwide production of lentil was 6.5 million tonnes, amidst which Canada is the biggest producer with 45% of total world production which is accompanied by India which holds 18% of world`s total production. (FAOSTAT). In case of India, Uttar Pradesh and Madhya Pradesh are biggest producers and these two states in conjunction produces about more than 70% of the total national production. Other prime producers comprehend Bihar and West Bengal. (agriexchange.apeda.gov.in, 2020).

Lentils are very feeble competitors with weeds. Decrease in yield from 20 percent up-to 84 percent has been contemplated due to the weed competition. Slow emergence, small stature of crop, late canopy cover of cool season lentil are the principle factors which allows weed competition. In no tillage planting system, emergence of the plants and canopy closure is contemplated to be very late. Prior emerging weeds which emerge before the crops have a competitive ascendancy over late emerging crops and such weeds can reduce the yield if not administered on time. Late growing weed species in lentil for instance *Lathyrus aphava, Vicia sativa, vicia hirsuta* produces seeds indistinguishable in semblance to lentil and differentiation among crop seed and weed seed is sturdy, which results into poor quality of yield (Brand *et al*., 2007) Mainly herbicides which are suggested to be used in lentil were formerly developed for soybean and prior published reports depict deficiency of effective herbicides and demand to explore the range of herbicides. Integrated weed management practices in lentil is extremely essential because of its feeble competitive nature. Inaccessibility of efficient herbicide and necessity of crop rotation for disease/pest management. Integration of two or more management strategies (preventive, cultural, mechanical or chemical) is the root for integrated weed management. (Yenish *et. al* 2009; Brand *et al*, 2007). Growth rates are slow in lentil plants at the time of early stages of vegetative growth and during this period of time weeds can rapidly encroach the crop if they aren`t sufficiently administered. Weeds contend with the main crop for the resources like nutrients, moisture, space and sunlight, reducting the yields of the crop and quality of food-grain produced (Turk & Tawaha 2003).

Weeds are a major issue in lentil, if not controlled timely can cause yield loss up-to 80%. Weeds must be controlled in lentil before the Critical period of weed control. Hence, the study had been undertaken to find out an efficient way to control weeds in lentil.

MATERIALS AND METHODS

A field experiment had been conducted during the Rabi season of 2021-22 at Uttaranchal University, Premnagar, Dehradun, Uttarakhand (30.33 º N Latitude and 77.95 º E Longitude) India. The maximum and minimum temperatures of the place is 27.65ºC and 13.8ºC respectively. The soil of the experimental site contained sand 53.40 %, silt 25.40% and clay 21.30%. The soil texture was Sandy loam having pH almost neutral which is 7.4 and organic carbon 0.83%. The available Nitrogen 297.8 kg/ha, available P 13.8 kg/ha and available K was 237.5 kg/ha. The experimental design selected for this purpose was randomised block design using 3 replications and 8 treatments. . The treatments applied were T_1 as Control, T_2 as Two hand-weeding, T_3 as Atrazine @ 1kg a.i. per hectare, T_4 as Atrazine + 1 hand-weeding, T_5 as Pendimethalin @ 1kg a.i. per hectare, T_6 as Pendimethalin + 1 hand-weeding, T_7 as Isoproturon @ 1 kg a.i. per hectare and T_8 as Isoproturon + 1 hand-weeding. The sowing had been done on 26th November and the harvesting had been done on 13th of April. Seed rate was 40 kg/ha and the recommended dose of fertilizer that is 20 kg/ha of N, 40 kh/ha of P and 20 kg/ha of S. The application of pre-emergence herbicide was done on 25th November. The post-emergence herbicide application was done at 45 days and 2 hand-weeding was performed at 30 and 60 DAS respectively. In treatments of herbicide + 1 hand-weeding was done at 45 DAS. The crop variety used was VL-Masoor.

RESULTS AND DISCUSSION

The major weed flora observed in the field were *Anagallis arvensis, Parthenium hysterophorous, Chenopodium album, Elymus repens* etc. some of the few minor weeds were *Phalaris paradoxa, Setaria viridis, Melilotus alba, Argemone mexicana, Cyperus rotundus* etc.

Weed density

Weed density refers to the population of weed plant per square meter. In case of weed density, treatments of Pendimethalin + 1 hand-weeding and 2 hand-weeding were statistically at par to each-other. The best weed control had been observed in plots with the treatment Pendimethalin + 1 hand-weeding and the lowest weed control had been observed in T1 which was Control. The results were in accordance with Gupta and Rao (2013). The weed density was recorded randomly from selected area of 50cm x 50cm from each-plot.

Out of all the herbicide (solely) treated plots and the plots treated with herbicide as well as hand weeding, the treatment of Isoproturon alone was least effective to the weeds and also the herbicide toxicity caused by it was the highest in those plots. This has been confirmed by (Leoci & Ruberti).

Weed biomass

The total weed biomass had been observed once at 90 DAS in terms of Kg/hectare. The highest weed biomass was observed in Control (763.3 kg/ha) and the lowest was in the treatment of Pendimethalin+ 1 hand-weeding (329.83 kg/ha). The best control of weed biomass was observed in Pendimethalin+ 1 hand-weeding followed by the treatment of 2 hand-weeding (349.96 kg/ha) and Atrazine + 1 hand-weeding (369.93 kg/ha) The treatments of Two hand-weeding as well as Atrazine + 1 hand-weeding are statistically at par to one-another. (Singh *et al.,* 2014).

Weed Control Efficiency (%)

The efficiency of weed control refers to the percentage of weed plant reduced after application of certain treatment. The weed control efficiency (%) was observed to be highest in the treatment of Pendimethalin + 1 hand-weeding (56.78 %) followed by the treatment of Two hand-weeding (52.54%) and Atrazine + 1 hand-weeding (51.52%). The result is in accordance with the confirmation of Bhattarai *et al.* 2018.

Plant population

The plant population was observed two time during the crop life-cycle. Once when the emergence was complete that is 21 DAS and once at harvest. The population of plants at harvest was slightly lower at the time of harvest due to weather conditions as well as herbicide toxicity and some plants were taken for laboratory observations. Atrazine toxicity to lentil crops was confirmed by Wang *et al*. 2015. Isoproturon is not only harmful to plants, soil, and the environment but also is harmful for human health as confirmed by (Adama, 2016; Muller &Applebyki, 2018). It was reported to cause herbicide phyto-toxicity at initial stage and is banned in several countries. At harvest, highest plant population had been observed in T_2 which is Two hand weeding (159) followed by T_6 which is Pendimethalin + one hand-weeding (152) and the lowest was in T_1 which is Control (139).

N depletion

The depletion of nitrogen has notably been affected by various weed management practices. The N depletion had been noted highest in T_1 or Control (26.70 kg/ha). The N depletion had been lowest in T_2 or Two hand-weeding (7.10 kg/ha). T_6 (7.53 kg/ha) which is Pendimethalin + One hand-weeding was noted to be statistically at par to T_2. The N depletion was observed to be higher in those treatments which were using chemicals solely.

P depletion

The depletion of P had been influenced by various weed management practices applied. The P depletion had been observed highest in T_1 or Control (4.93kg/ha). It was lowest in T_2 or Two hand-weeding plot (1.32kg/ha). T_6 which is Pendimethalin + One hand-weeding (1.51 kg/ha) is observed to be statistically at par to T_2. Higher P depletion was observed in treatments based on chemicals solely.

K depletion

Different weed management practices influence K depletion in soil differently. The K depletion was highest in T_1 or Control (19.27 kg/ha). It was observed lowest in T_2 which is Two hand-weeding (5.09 kg/ha). T_6 (5.15kg/ha) which is

Pendimethalin + One hand-weeding is statistically at par to T_2. Comparatively higher K depletion was found in plots with treatments of chemicals (solely).

Nutrient majorly are N, P and K. the higher weed population leads to higher depletion in the nutrient content of the soil. More the weed population, more would be the depletion of the nutrients. Herbicides too have a crucial role in depletion of soil nutrients. The best method to prevent nutrient depletion is to provide cultural practices to the field as confirmed by Kumar and Nandan, 2014.

Table 1: Effect of weed control practices on density of different weeds (60 DAS)

Treatments	*Elymus repens*	*Chenopodium album*	*Parthenium hysterophorous*	*Anagallis arvensis*	Other minor weeds
T_1 (CONTROL)	20.66	15.60	7.66	16.63	9.70
T_2 (2 Hand weeding)	3.40	3.33	2.90	3.40	2.40
T_3 (Atrazine (PE), ATRATEX 50% WP @ 1kg a.i. per hectare)	5.30	5.06	4.40	5.13	3.42
T_4 (Atrazine (PE) + 1 Hand weeding)	4.00	4.00	3.16	4.30	3.60
T_5 (Pendimethalin PoE, PENDANT 30% EC @ 1kg a.i. per hectare)	5.16	4.73	4.00	4.70	4.53
T_6 (Pendimethalin (PE) + 1 hand weeding)	3.20	2.96	2.60	3.26	2.00
T_7 (Isoproturon (PoE) SHIVRON 75% WP @ 1kg a.i. per hectare)	5.10	5.13	4.60	6.30	4.43
T_8 (Isoproturon (PoE) + 1 Hand weeding)	4.63	4.50	3.80	6.40	3.8
SEm±	0.01	0.06	0.02	0.05	0.01
CD (P≥0.05%)	0.23	0.13	0.24	0.39	0.22

Table2: Effect of weed control practices on density of different weeds (90DAS)

Treatments	*Elymus repens*	*Chenopodium album*	*Parthenium hysterophorous*	*Anagallis arvensis*	Other minor weeds
T_1 (CONTROL)	25.96	19.96	10.70	22.06	11.50
T_2 (2 Hand weeding)	3.83	3.40	2.96	3.86	2.76
T_3 (Atrazine (PE), ATRATEX 50% WP @ 1kg a.i. per hectare)	5.43	5.70	4.56	5.06	3.80
T_4 (Atrazine (PE) + 1 Hand weeding)	4.70	4.46	3.50	4.43	3.13
T_5 (Pendimethalin PoE, PENDANT 30% EC @ 1kg a.i. per hectare)	5.70	5.76	4.50	4.80	4.13
T_6 (Pendimethalin (PE) + 1 hand weeding)	3.43	3.16	2.30	3.46	2.30
T_7 (Isoproturon (PoE) SHIVRON 75% WP @ 1kg a.i. per hectare)	6.13	5.70	4.70	7.02	4.01
T_8 (Isoproturon (PoE) + 1 Hand weeding)	5.13	5.46	3.83	6.50	3.40
SEm±	0.10	0.04	0.01	0.07	0.03
CD (P≥0.05%)	0.55	0.36	0.17	0.44	0.34

Table 3: Effect of weed control practices on weed biomass and Weed Control Efficiency (WCE) %.

Treatments	**Weed biomass 90 DAS (Kg/ha)**	**WCE (%)**
T_1 (CONTROL)	763.3	0
T_2 (2 Hand weeding)	349.96	52.54
T_3 (Atrazine (PE), ATRATEX 50% WP @ 1kg a.i. per hectare)	392.46	48.58
T_4 (Atrazine (PE) + 1 Hand weeding)	369.93	51.52
T_5 (Pendimethalin PoE, PENDANT 30% EC @ 1kg a.i. per hectare)	405.43	46.87
T_6 (Pendimethalin (PE) + 1 hand weeding)	329.83	56.78
T_7 (Isoproturon (PoE) SHIVRON 75% WP @ 1kg a.i. per hectare)	432.53	43.33
T_8 (Isoproturon (PoE) + 1 Hand weeding)	401.40	47.40
SEm±	12.06	1.57
CD (P≥0.05%)	6.08	2.19

Table 4: Effect of weed control practices on plant population

Treatments	21 DAS	At harvest
T_1 (CONTROL)	159.66	139.33
T_2 (2 Hand weeding)	177.00	159.00
T_3 (Atrazine (PE), ATRATEX 50% WP @ 1kg a.i. per hectare)	169.33	145.33
T_4 (Atrazine (PE) + 1 Hand weeding)	174.00	149.00
T_5 (Pendimethalin PoE, PENDANT 30% EC @ 1kg a.i. per hectare)	179.00	145.33
T_6 (Pendimethalin (PE) + 1 hand weeding)	172.00	152.00
T_7 (Isoproturon (PoE) SHIVRON 75% WP @ 1kg a.i. per hectare)	177.33	143.00
T_8 (Isoproturon (PoE) + 1 Hand weeding)	179.00	147.00
SEm±	5.03	1.58
CD (P≥0.05%)	3.92	2.20

Table: 5 Effect of various weed control methods on depletion of nutrients by weeds

Treatments	Nutrient depletion by weeds (kg/ha)		
	N	P	K
T_1 (CONTROL)	26.70	4.93	19.27
T_2 (2 Hand weeding)	7.10	1.32	5.09
T_3 (Atrazine (PE), ATRATEX 50% WP @ 1kg a.i. per hectare)	11.33	2.34	9.21
T_4 (Atrazine (PE) + 1 Hand weeding)	10.50	1.97	6.56
T_5 (Pendimethalin PoE, PENDANT 30% EC @ 1kg a.i. per hectare)	11.21	2.26	9.05
T_6 (Pendimethalin (PE) + 1 hand weeding)	7.53	1.51	5.15
T_7 (Isoproturon (PoE) SHIVRON 75% WP @ 1kg a.i. per hectare)	11.59	2.57	9.33
T_8 (Isoproturon (PoE) + 1 Hand weeding)	10.64	2.01	6.85
SEm±	1.58	0.32	1.07
CD (P≥0.05%)	4.21	0.79	3.14

Conclusion:

The outcome of the experiment shows that the best weed control is obtained when both the agronomic and chemical practices are integrated with one another. In terms of weed control and Weed Control Efficiency, best results were obtained by Pendimethalin + one hand-weeding. The treatment of Two hand-weeding is also equally efficient. However, the lowest nutrient depletion due to weeds and weed control practices was observed in the treatment of Two hand-weeding but for larger areas hand-weeding alone is not feasible. Hence, integration of chemical and cultural practices gives the best outcome in control of weeds. Other herbicides like Atrazine and Isoproturon were quite effective in control of weeds but also hampered the crops as it caused toxicity to the crops. Legumes are effected more than cereal crops.

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