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Chemical weed management in lentil

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Abstract
A field experiment was conducted at Regional Research Station Samargopalpur Farm, Rohtak during *Rabi* 2014-15 and *Rabi* 2015-16. Treatments included were pendimethalin 1000g/ha as PPI and PRE, imazethapyr 50 g/ha as PPI, PRE and POST, pendimethalin 1000 g/ha PPI + imazethapyr 50 g/ha PPI, pendimethalin 1000 g/ha PRE + imazethapyr 50 g/ha PRE, pendimethalin 1000 g/ha PRE *fb* imazethapyr 50 g/ha POST, weed free and weedy check. The experiment was laid out in RBD design with three replications. Application of herbicidal treatments resulted into significantly higher lentil plant growth, seed yield and lower weed dry weight as compared to weedy check treatment but lentil yield remained significantly higher under weed free conditions as compared to all other treatments during both the year of study. PRE application of pendimethalin was better than its PPI application while PPI application of imazethapyr was better than its PRE and POST application. Mixed and sequential application of pendimethalin and imazethapyr resulted into significantly higher plant growth, yield attributes and lentil seed yield and better weed control efficiency as compared to their alone application during both the years.

Keywords: Lentil, imazethapyr, pendimethalin, weed control efficiency, pre-emergence

Introduction
Pulses are principal source of dietary protein and therefore, constitute chief ingredient of vegetarian diet in developing countries like India. In addition to being a good source of dietary proteins and income to farmers, pulses play an important role in sustainable crop production. They are an important component of cropping systems to maintain soil health because of their ability to fix atmospheric nitrogen, extract water and nutrients from deeper layers of soil, and add organic matter into soil through leaf drop. The major pulse crops grown in India are chickpea, pigeon pea, lentil, mungbean, urdbean and fieldpea. Lentil (*Lens culinaris* Medikus), locally known as Masoor, is an important rabi season pulse crop which is grown in North America, Southern Europe, North Africa, West Asia and northern and central parts of India. In India, it is grown on an area of about 1.3 million hectares with an average production of 0.98 million tonnes, and productivity level of 765 kg /ha (Anonymous, 2017) [1]. It is not only a rich source of improved nutrition for people but also provide nutritious straw for cattle. Lentil contains about 11 per cent water, 25 per cent protein and 60 per cent carbohydrate. It is also rich in calcium, iron and niacin and high lysine and tryptophane content. As an added bonus its storage is not complicated and it can be kept in a cool dry place for an indefinite amount of time without loss in nutritional value, taste or freshness. Bahl *et al.* (1993) [2] reported that lentil is probably the oldest of grain legumes to be domesticated. Lentil is grown in most parts of India. It is hardier and capable of withstanding extremes of weather and soil condition. However, due to its short stature, slow initial growth and long duration, its productivity is adversely affected by the presence of weeds. The prominent weed species infesting lentil crop are *Chenopodium album, Anagallis arvensis, Convolvulus arvensis, Rumex dentatus, Phalaris minor, Melilotus indicus* etc. The concept that high input in high yield also means is high risk, if weeds are not controlled. A weed free crop environment is therefore important both for increasing yield and income for the security of crop. During recent past, it has been progressively realized that for a more permanent agriculture, one must develop concept of "Weed management" in variance with the more popularly known weed control. There are number of reasons of low production and productivity of lentil out of which weeds, being serious negative factors in crop production are responsible for reduction in the yield of lentil to a tune of 84 percent (Mohamed *et al*., 1997) [3]. It is estimated that loss in seed yield may likely to go to the extent of 45-65% under condition (Mishra, 2006) [4]. During winter season, broad leaved weeds may become dominant in the early stages of crop growth because of their

fast growth and deep root system. To control weeds generally hand weeding is in practice that is now costly as well as difficult because of non-availability of labour in peak period. With the advancement of agro techniques, chemical weed control is become an effective and cheap alternative to control weeds.

Materials and Methods

A field experiment was conducted at Regional Research Station Samargopalpur Farm, Rohtak during *Rabi* 2014-15 and *Rabi* 2015-16 comprising of ten treatments *viz.* pendimethalin 1000g/ha as PPI (pre-plant incorporation) and PRE (pre-emergence), imazethapyr 50 g/ha as PPI, PRE and POST (post-emergence), pendimethalin 1000 g/ha PPI + imazethapyr 50 g/ha PPI, pendimethalin 1000 g/ha PRE + imazethapyr 50 g/ha PRE, pendimethalin 1000 g/ha PRE *fb* imazethapyr 50 g/ha POST, weed free and weedy check. The experiment was laid out in RBD design with three replications. The soil of field was sandy loam with pH 7.8 low in nitrogen, medium in phosphorus. Sapna variety of lentil was sown during both the years of study. The sowing of lentil was done on 12th November during *Rabi* 2014-15 and 25th November during *Rabi* 2015-16 by using 45 kg/hectare seed of lentil with a row spacing of 22.5 cm. The herbicides were applied using knap sack sprayer fitted with flat fan nozzle using 600 litre water/ha for PRE and PPI application and 325 litre water/ha for POST application. The major weeds in experimental fields were *Chenopodium album*, *Anagalis arvensis*, *Convolvuls arvensis*, *Rumex dentatus* and *Phalaris minor*. The crop was raised under irrigated condition with recommended package of practice of CCSHAU, Hisar, except weed control treatment. The crop was harvested manually on 10th April, 2015 during 1st year and on 14th April, 2016 during 2nd year of study. Observations of yield and growth parameters like plant height (cm), number of branches/plant, number of pod/plant, number of grain/pod, test weight (g), seed yield (kg/ha), dry weight of weeds (g/m^2) were taken from the experimental plots from randomly selected area of 50×50 cm and weed control efficiency (WCE) was calculated as per the standard formula.

Results and Discussion

Effect on weeds and crop growth

Highest plant height was recorded under weed free condition which was significantly higher than weedy check and POST application of imazethapyr during both years (Table 1). Plant height of lentil under all herbicidal treatments, except POST application of imazethapyr, remained at par with weed free situation. During both years, application of various herbicides resulted into significantly more number of branches per plant of lentil as compared to weedy check, however, maximum number of branches per plant were observed under weed free plots which were significantly higher than all other treatments (Table 1). Lesser weeds in treated plots might have resulted into taller plants and more number of branches. Application of various herbicides resulted into significantly lower weed dry weight as compared to weedy check treatment (Table 1) during both the year of study. For controlling the weeds, PRE application of pendimethalin was better than its PPI application while PPI application of imazethapyr was better than its PRE and POST application in terms of weed dry weight and weed control efficiency. Mixed and sequential application of pendimethalin and imazethapyr resulted into significantly lower weed dry weight and better weed control efficiency as compared to their alone application during both years (Table 1). Similarly, Chandrakar *et al.* (2015) [5] observed that pendimethalin + imazethapyr 1.0 kg/ha at pre emergence recorded taller plants, higher number of branches per plant and lowest weed dry weight in lentil crop. Godara and Deshmukh (2002) [6] also reported similar result in soybean.

Table 1: Effect of herbicides on lentil plant growth and weed control efficiency

Treatments	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
	Plant height (cm)	Plant height (cm)	No. of branches/ plant	No. of branches/ plant	weed dry weight (g/m^2)	weed dry weight (g/m^2)	Weed control efficiency (%)	Weed control efficiency (%)
Weedy check	44.7	46.9	8.10	8.44	175.7	161.4	0.00	0.00
Weed free	47.1	49.5	11.01	11.47	0.0	0.0	100.00	100.00
Pendimethalin 1000g/ha as PPI	45.5	47.6	9.61	10.02	98.3	91.4	44.05	43.37
Pendimethalin 1000g/ha as PRE	46.0	48.3	9.72	10.18	77.0	71.6	56.18	55.64
Imazethapyr 50 g/ha as PPI	46.3	48.4	9.51	9.91	66.1	61.4	62.38	61.96
Imazethapyr 50 g/ha as PRE	45.3	47.5	9.61	10.02	88.3	82.1	49.74	48.73
Imazethapyr 50 g/ha as POST	42.4	44.5	9.46	9.85	94.7	87.1	46.10	45.93
Pendimethalin 1000 g/ha PPI+ imazethapyr 50 g/ha PPI	46.2	48.5	10.32	10.77	35.9	33.4	80.07	79.31
Pendimethalin 1000 g/ha PRE+ imazethapyr 50 g/ha PRE	46.4	48.7	10.46	10.86	52.2	48.5	70.29	69.95
Pendimethalin 1000 g/ha *fb* imazethapyr 50 g/ha POST	42.6	44.7	10.41	10.81	44.1	41	75.10	74.49
SEm±	0.5	0.6	0.15	0.16	2.3	2.1	-	-
CD at 5%	1.8	1.9	0.48	0.51	7.1	6.5	-	-

Effect on crop yield

Application of various herbicides resulted into significantly higher number of pods per plant, number of grains per pod, test weight and crop yield as compared to weedy check treatment during both the year of study (Table 2). Maximum number of pods per plant and number of grains per pod were recorded under weed free condition which was significantly higher than all other treatments. PRE application of pendimethalin recorded significantly more number of pods per plant than its PPI application while PPI application of imazethapyr was significantly better than its PRE and POST application during both years (Table 2). Uncontrolled weeds under weedy check resulted into significantly lower test weight and seed yield of lentil as compared to all other treatments during both years. Maximum test weight and seed yield of lentil was observed under weed free condition which remained significantly higher than all other treatments. Among herbicides, PRE application of pendimethalin was better than its PPI application while PPI application of imazethapyr was better than its PRE and POST application in terms of test weight and seed yield of lentil. These findings are in close proximity with that of Ram *et al.* (2012) [7] with imazethapyr on field pea. Mixed as well as sequential application of pendimethalin and imazethapyr resulted into significantly higher test weight and seed yield as compared to their alone application during both years (Table 2). Chandrakar *et al.* (2015) [5] also observed that application of pendimethalin + imazethapyr 1.0 kg/ha at pre emergence recorded more number of pods per plant, higher number of seeds per plant, test weight and seed yield of lentil crop.

Table 2: Effect of herbicides on yield attributes and yield of lentil

Treatments	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
	No. of pods/plant	No. of pods/plant	No. of grains/pod	No. of grains/pod	Test weight (g)	Test weight (g)	Grain yield of lentil (kg/ha)	Grain yield of lentil (kg/ha)
Weedy check	74	76	1.67	1.74	25.63	26.71	1077	1288
Weed free	112	118	1.86	1.94	28.70	29.93	1924	2278
Pendimethalin 1000g/ha as PPI	78	83	1.74	1.81	26.30	27.41	1251	1491
Pendimethalin 1000g/ha as PRE	90	95	1.76	1.82	26.50	27.65	1462	1747
Imazethapyr 50 g/ha as PPI	94	99	1.76	1.83	26.88	28.02	1539	1827
Imazethapyr 50 g/ha as PRE	82	87	1.74	1.82	26.40	27.53	1347	1593
Imazethapyr 50 g/ha as POST	80	85	1.75	1.81	26.30	27.48	1308	1558
Pendimethalin 1000 g/ha PPI+ imazethapyr 50 g/ha PPI	97	103	1.78	1.85	27.55	28.77	1635	1939
Pendimethalin 1000 g/ha PRE+ imazethapyr 50 g/ha PRE	99	105	1.80	1.87	27.74	28.94	1693	2017
Pendimethalin 1000 g/ha *fb* imazethapyr 50 g/ha POST	96	102	1.79	1.86	27.65	28.83	1626	1929
SEm±	2.3	2.6	0.02	0.02	0.18	0.20	23	26
CD at 5%	7.3	8.1	0.06	0.06	0.58	0.61	74	79

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