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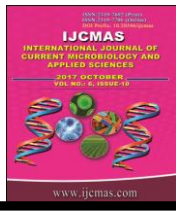

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Impact of Fertility Levels and Weed Management Practices on Weed Dynamics and Yield of Lentil (*Lens culinaris* Medikus) under Eastern U.P. Conditions

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A B S T R A C T

An experiment was conducted during the *Rabi* season of 2012-13 and 2013-14 to examine the effects of fertility levels and weed management practices on weed density, growth parameters and yield of lentil (*Lens culinaris* Medikus). The experiment was laid out in split-plot design comprising six main plot treatments *viz.* Control (F_0), 100% RDF (F_1), 75% RDF + 2% urea spray at pre-flowering and pod initiation stage (F_2), 75% RDF + Plantgro 9 kg/ha at 35, 50 and 65 DAS as foliar spray (F_3), 100% RDF + 2% urea spray at pre-flowering and pod initiation stage (F_4), 100% RDF+ Plantgro 9 kg/ha at 35, 50 and 65 DAS as foliar spray (F_5) and four sub-plot treatments *viz.* unweeded (W_0), weed free (W_1), pendimethalin 1 kg a.i./ha (W_2), imazethapyr 37.5 g a.i./ha (W_3). The major group of weeds found in the experimental field was *Cyperus rotundus*, *Chenopodium album*, *Solanum nigrum* and *Cynodon dactylon*. The results indicated that fertility levels and weed management had a significant effect on weed population dynamics and lentil crop. Higher yield attributes, yield and harvest index was recorded with the treatment 75% RDF + Plantgro 9 kg/ha. Higher grain yield (1283.08 kg/ha) was recorded with 75% RDF + Plantgro 9 kg/ha whereas straw yield (2140.64 kg/ha), net returns 23218.09 (Rs./ha) and B:C ratio (2.29) was obtained with 100% RDF+ 2% urea spray. The increase in yield was 11.41 % and 29.83% over 100% RDF + 2% urea spray and control respectively. Highest N, P, K uptake (50.08, 7.29 and 22.92 kg/ha) respectively was recorded with 75% RDF + Plantgro 9 kg/ha. Total weed count and dry weight decreased significantly with the application of post-emergence application of imazethapyr 37.5 g/ha and was comparable to pendimethalin 1 kg/ha. Highest weed control efficiency of 68.87% was recorded with imazethapyr 37.5 g/ha. Higher grain yield (1088.05 kg/ha), straw yield (2121.43 kg/ha), net returns 22625.76 and B: C ratio (2.35) was recorded with imazethapyr 37.5 g/ha. This treatment also recorded the highest N (39.84 kg/ha), P (4.88 kg/ha), K (15.93 kg/ha) uptake and protein content (22.72%) of lentil.

Introduction

At the global level, though India's share in lentil production is quite large (30%), yet the production (0.95 mt) and productivity level (633.33 kg/ha) in the country is substantially low (FAOSTAT, 2014). The low average yield might be due to poor level of crop management, growing lentil on marginal lands with low fertilizer inputs and inadequate

weed management. Foliar application is regarded as a preferred solution when the quick supply of nutrients is hindered or the soil conditions are conducive for the absorption of nutrients (Salisbury and Ross, 1995). Urea is the most suitable nitrogen source for foliar application due to its low salt index and high solubility in comparison to other nitrogen sources Plant GRO MAGIC is a fertilizer product which is a multinutrient water soluble fertilizer (57.1% total nutrients) and includes nitrogen, phosphorus and potassium as primary nutrients. It has been found that weeds reduce yield of lentil to the extent of 73% (Phogat *et al.*, 2003) and under high densities of weeds losses can reach even up to 100%. Weed infestation in lentil is high due to its slow initial growth, short stature and shallow root system. The most effective method of controlling weeds in lentil is hand weeding. But, this technique is feasible only on small farms and under sufficient labour availability. The use of herbicides as an alternative to hand weeding can be feasible and more economical than hand weeding. Pre-emergence herbicides like pendimethalin are effective only for a period of initial 30 days and at later stages, crop gets infested with weeds. Therefore, the use of post-emergence herbicide needs to be advocated in lentil. There is a need to develop most effective and economical fertilizer management and weed control practices for obtaining higher yield as well as profitability. Keeping these facts in view, the present experiment was designed to determine the best suitable fertilizer and weed management technique for lentil crop.

Materials and Methods

Field experiment was conducted during the winter season of 2012-13 and 2013-14 at dryland research farm of Banaras Hindu University, Varanasi (U.P.) to examine the performance of lentil under varying fertility levels and weed management treatments. The experimental site is located at $25^0$18' North latitude, $83^0$3' East longitude and at altitude of 76.60 meter above the mean sea level (MSL) in the Northern Gangetic Alluvial Plain. A composite representative soil sample was collected and was analysed for physico-chemical properties. The soil was clay loam in texture with pH 7.31 (1:25 soil and water ratio), 0.37% organic carbon (Walkley and Black, 1937), 212.50 kg/ha available nitrogen (Subbiah and Asija, 1956), 25.17 kg/ha available phosphorus (Olsen *et al.*, 1954) and 234.15 kg/ha potassium (Jackson, 1973) before the start of the experiment. The experiment was replicated thrice in split-plot design with six fertility levels *viz*. Control (F_0), 100% RDF (F_1), 75% RDF + 2% urea spray at pre-flowering and pod initiation (F_2), 75% RDF + Plantgro 9 kg/ha at 35, 50 and 65 DAS as foliar spray (F3), 100% RDF + 2 % urea spray at pre-flowering at pod initiation (F_4), 100% RDF + Plantgro 9 kg/ha at 35, 50 and 65 DAS as foliar spray (F_5) and four weed management practices *viz*., Unweeded (W_0), weed free (W_1), pendimethalin 1.0 kg/ha (W_2), imazethapyr 37.5 g/ ha (W_3). A uniform dose of 20, 40, 30 kg N, P_2O_5, K_2O/ha was applied to different plots as per the treatment requirements through urea, Single super phosphate and Muriate of potash respectively. Full dose of recommended fertilizers were applied as basal before sowing. Lentil variety HUL-57 (Malviya-Vishwanath) was sown on 23 Novemeber in 2013 and 21 November in 2014, respectively using a seed rate of 40 kg/ha at row spacing of 25 x 5 cm and following all standard package and practices. Hand weeing was done with the help of khurpi at an interval of 25 days or whenever weeds were observed in weed free plots. Pendimethalin was applied as pre-emergence using Knapsack sprayer fitted with flat fan nozzle by mixing 500 litres of water/ha. Post-emergence herbicide Imazethapyr was applied at 2-4 leaf stage of weed. The observations on weed dry matter

were taken randomly from 0.5 m x 0.5 m quadrate from 2 spots from each plot at the time of harvest. The weed samples were sun-dried for 2-3 days and then dried in oven at 70^0C for 48 hours to obtain a constant weight. The data on weed experiment were subjected to square root transformation $\sqrt{x + 0.5}$ for uniformity. The crop was harvested at 24 March in 2013 and 22 March in 2014 respectively.

Weed free and unweeded control treatments were kept for comparison with different treatments. Yield attributes *viz*. number of seeds/pod, test weight and yield *i.e*. grain yield (kg/ha) and straw yield (kg/ha) were recorded at harvest during both the years. Net returns were calculated by using prevailing prices of inputs and outputs during the respective crop season. Benefit: cost ratio was calculated by dividing the net returns from the cost of cultivation. The data was analysed using standard ANOVA for split-plot design and the significance of differences between the treatments means were compared with critical differences at 5% level of probability.

Results and Discussion

Weed flora

Weed flora of the experimental field consisted of grasses, sedges and broad leaved weeds. The dominant weed flora included *Cyperus* spp. among sedges, *Chenopodium album* and *Solanum nigrum* among broad-leaved weeds and *Cynodon dactylon* among the grassy weeds. *Parthenium hysterophorus*, *Fumaria parviflora*, *Anagallis arvensis*, *Vicia sativa*, *Melilotus indica*, *Medicago polymorpha* were found in negligible presence. Sedges dominated the experimental field to the extent of 42% followed by broad-leaved and grassy weeds. These results are supported with the findings of Bhowmick *et al.,* (2010). This might be due to the reason that application of pre-emergence herbicide might have controlled the weeds at the initial stage of the crop. Further, pendimethalin is used in crops for selective control of annual broad leaved weeds and grasses but it is ineffective for sedges.

Effect on weeds

It was observed that lowest weed count and dry weight of weeds was recorded with 75% RDF + Plantgro 9 kg ha^{-1} and was at par with the application of 100 % RDF + 2% urea spray. However, all the fertility level treatments were significantly superior to control in minimizing the total weed count of all weeds. Weed management treatments significantly influenced total weed count and total weed dry weight. Significantly lowest weed count and dry weight was noted under the post-emergence application of imazethapyr 37.5 g/ha and was at par with the application of pendimethalin 1 kg/ha and highest with unweeded control. Effectiveness of post-emergence herbicides for weed control in various pulse crops has been reported by Kumar (2008). However, neither of the herbicides was as effective as hand weeding in recording the lower total weed count.

Weed control efficiency (%)

The higher weed control efficiency was achieved under application of 75% RDF + Plantgro 9 kg ha^{-1} and was at par with 100% RDF + 2% urea spray application. Weed dry matter was reduced under highest level of nutrients. Similar trend was reported by Prajapati *et al.,* (2003) in Gujarat. Among the herbicidal application treatments, the highest weed control efficiency was associated with weed free which might be attributed due to its effective control of complex weed flora *viz*., grasses, sedges and broad-leaved weeds in which the broad leaved weeds were

suppressed before weed seed sprout. Among the herbicidal treatments, higher weed control efficiency was obtained with post-emergence application of imazethapyr 37.5 g/ha. This might be due to lower weed population and reduced dry matter production of weeds which were effectively controlled by imazethapyr (Table 1).

Table.1 Total weed count, weed dry weight, weed control efficiency and nutrient depletion by weeds as influenced by fertility levels and weed management (pooled data of two years)

Treatments	Total weed count (No. m^{-2})	Total weed dry weight (g m^{-2})	Weed control efficiency (%)	Nutrient depletion (kg/ha)		
				N	P	K
A. Fertility levels						
F_0 Control	6.99 (70.34)	7.03 (68.26)	56.40	4.86	0.75	2.31
F_1 100% RDF	6.40 (57.82)	6.30 (52.88)	60.03	3.26	0.43	1.50
F_2 75% RDF+ 2% urea spray at pre-flowering and pod initiation	6.72 (63.57)	6.42 (54.94)	56.99	3.61	0.51	1.67
F_3 75% RDF + Plantgro 9 kg/ha at 35, 50, 65 DAS as foliar spray	5.86 (48.99)	5.79 (45.49)	60.25	2.57	0.35	1.16
F_4 100% RDF + 2% urea spray at pre-flowering and pod initiation	6.16 (53.49)	5.99 (47.62)	60.14	2.98	0.40	1.35
F_5 100% RDF + Plantgro 9 kg/ha at 35, 50, 65 DAS as foliar spray	6.73 (65.51)	6.72 (62.05)	56.47	4.01	0.59	1.92
S Em ±	0.03	0.04	-	0.14	0.007	0.018
CD (P = 0.05)	0.09	0.12	-	0.45	0.022	0.053
B. Weed management						
W_0 Unweeded	12.70 (161.49)	11.52 (133.29)	0.00	7.16	1.03	3.38
W_1 Weed free	0.71 (0.00)	0.71 (0.00)	100.00	0.00	0.00	0.00
W_2 Pendimethalin 1.0 kg/ha	6.91 (47.47)	6.84 (46.54)	64.64	4.33	0.61	1.96
W_3 Imazethapyr 37.5 g/ha	5.59 (30.85)	6.43 (40.93)	68.87	2.70	0.39	1.26
S Em ±	0.02	0.03	-	0.10	0.008	0.015
CD (P = 0.05)	0.06	0.07	-	0.27	0.023	0.044

Table.2 Growth attributes, yield attributes and yield of lentil as influenced by fertility levels and weed management (Pooled data of two years)

Treatment	Growth attributes (90 DAS)			Yield attributes			Yield		Harvest index (%)
	Plant height (cm)	Branches/ plant	Dry matter accumulation (g/m^2)	No. of pods/plant	No. of seeds/pod	Test weight (g)	Grain yield (kg/ha)	Straw yield (kg/ha)	
A. Fertility levels									
F_0 Control	30.21	5.27	45.07	34.18	1.73	20.29	900.33	1806.14	33.19
F_1 100% RDF	35.36	5.71	64.61	57.42	1.85	23.00	1096.98	1972.25	35.94
F_2 75% RDF+ 2% urea spray at pre-flowering and pod initiation	36.82	6.66	74.21	54.68	1.82	22.40	1027.41	1993.29	34.04
F_3 75% RDF + Plantgro 9 kg/ha at 35, 50, 65 DAS as foliar spray	36.95	7.01	79.80	62.26	1.98	25.20	1283.08	2140.64	37.96
F_4 100 % RDF + 2% urea spray at pre-flowering and pod initiation	37.01	7.15	84.15	58.79	1.87	23.65	1136.59	2357.74	32.82
F_5 100 % RDF + Plantgro 9 kg/ ha at 35, 50, 65 DAS as foliar spray	38.23	7.61	89.27	45.43	1.78	21.40	1028.37	2312.82	30.84
S Em ±	0.62	0.09	1.31	0.90	0.02	0.43	20.80	32.33	0.48
CD (P = 0.05)	1.82	0.26	3.87	2.67	0.06	1.27	61.37	101.87	1.40
B. Weed management									
W_0 Unweeded	32.83	5.97	66.15	37.82	1.73	21.20	953.66	1991.38	32.67
W_1 Weed free	38.18	7.22	82.41	61.19	1.97	24.01	1230.94	2167.24	36.46
W_2 Pendimethalin 1.0 kg/ha	35.42	6.41	69.24	53.74	1.79	22.28	1042.53	2108.54	33.48
W_3 Imazethapyr 37.5 g/ha	36.61	6.67	73.65	55.75	1.86	23.14	1088.05	2121.43	33.92
S Em ±	0.18	0.04	0.57	0.68	0.01	0.09	12.33	61.11	0.80
CD (P = 0.05)	0.51	0.11	1.61	1.93	0.03	0.26	34.75	175.02	2.26

Table.3 Effect of fertility levels and weed management on nutrient uptake and protein content of lentil (pooled data of two years)

Treatment	Nutrient uptake by crop (kg/ha)			Protein content (%)
	N	P	K	
A. Fertility levels				
F_0 Control (No fertilizer)	30.17	2.60	6.40	20.82
F_1 100% RDF	39.96	5.32	16.69	22.60
F_2 75% RDF+ 2% urea spray at pre-flowering and pod initiation	36.96	4.14	13.56	22.29
F_3 75% RDF + Plantgro 9 kg/ha at 35, 50, 65 DAS as foliar spray	50.08	7.29	22.92	24.27
F_4 100% RDF + 2% urea spray at pre-flowering and pod initiation	42.60	6.11	18.47	23.25
F_5 100% RDF + Plantgro 9 kg/ha at 35, 50, 65 DAS as foliar spray	36.30	4.08	12.48	21.97
SEm ±	1.15	0.16	0.47	0.19
CD (P = 0.05)	3.63	0.50	1.49	0.56
B. Weed management				
W_0 Unweeded	31.74	3.22	7.76	20.72
W_1 Weed free	49.30	7.41	22.81	24.90
W_2 Pendimethalin 1.0 kg/ha	36.51	4.18	13.85	21.78
W_3 Imazethapyr 37.5 g/ha	39.84	4.88	15.93	22.72
SEm ±	0.59	0.08	0.27	0.07
CD (P = 0.05)	1.68	0.24	0.77	0.21

Growth attributes

Among the fertility levels, 100% RDF +Plantgro 9 kg/ha recorded higher growth attributes (plant height, number of branches/plant and dry matter accumulation/plant) than 75% RDF + Plantgro 9 kg/ha (Table 2). Similar results were obtained by Shivran and Ahlawat (2000) and Chandel *et al.*, (2002).This might be attributed to higher supply of nutrients which led to greater vegetative growth and dry matter accumulation.

All the treatments of weed management showed significant enhancement in growth attributes over unweeded. Higher value of all the growth attributes was recorded with the application of imazethapyr 37.5 g/ha and was comparable to pendimethalin 1 kg/ha. This can be attributed to better control of weeds by imazethapyr at vegetative growth stage of crop which provided enough resources to the crop and a competition free environment.

Yield attributes and yield

Different fertility levels produced significant impact on yield attributes and yield of lentil over control. Significantly higher number of pods/plant, seeds/pod and test weight was recorded with the application of 75% RDF + Plantgro 9 kg/ha and it was at par with the application of 100 % RDF + 2% urea spray (Table 2). 75% RDF + Plantgro 9 kg/ha increased lentil grain yield increased to the tune of 11.41 % and 29.83% over 100% RDF + 2% urea spray and control respectively.

However, all the fertility levels proved significantly superior to control in increasing grain yield, straw yield and harvest index. Higher grain yield could be due to better development of yield attributes viz. pods/plant, seeds/pod and test weight. This might also be due to timely supply of macro and micronutrients in required amounts which was supplied through plantgro. Similar results were obtained by Singh *et al.,* (2014).Weed management treatments showed significant enhancement of yield attributes over control during both the years.

Among herbicide treatments, higher yield attributes and yield was recorded with the application of imazethapyr 37.5g/ha and was comparable with pendimethalin 1 kg/ha. This might be due to better suppression of weeds. Among controls, weedy check recorded significantly lower grain and straw yield compared to weed free treatment during both the years. All the weed control treatments were superior in terms of returns over weedy check.

Nutrient depletion by weeds and nutrient uptake by crop

It was observed that minimum nutrient depletion by weeds and highest uptake of nutrient by crop was recorded with the application of 75% RDF + Plantgro 9 kg/ha and was comparable to 100% RDF + 2% urea spray. All the fertility level treatments were significantly superior to control in minimizing the nutrient depletion by weeds and maximizing the nutrient uptake by crop (Table 3). This can be attributed to better availability of nutrients. Since the uptake of nutrient is a function of dry matter and nutrient content, the higher biological yield resulted into higher nutrient uptake by crop. Herbicidal application of exhibited significant effect on nutrient depletion by weed, nutrient uptake by crop and protein content in grain. Minimum nutrient depletion, highest nutrient uptake and protein content of lentil was observed under imazethapyr 37.5 g/ha. Unweeded control recorded lowest nutrient uptake. These results are in confirmation with the findings of Singh *et al.,* (2013.). It is inferred that application of 100% RDF + 2%

urea spray or 75 % RDF + Plantgro 9 kg/ha and weed management with imazethapyr 37.5 g/ha found to be most suitable for lentil crop.

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