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Efficacy of herbicides on weeds and yield of field pea (*Pisum sativum* L.) under irrigated condition

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ABSTRACT

An experiment was conducted during the rabi seasons of 2010-2011 at BHU, Varanasi, to evaluate the influence of herbicides on weeds and yield of field pea. Result indicated that application of pendimethalin 1kg ha [1] (PE) fb imazethapyr 50 g ha [1] (at 20 DAS as PoE) recorded significantly the lowest density and dry weight of weed, weed index, and the highest weed control efficiency, growth and yield attributes, grain and straw yield over imazethapyr 50 g ha [1] as (PoE), chlorimuron- ethyl 4 g ha [1] (PPI) and pendimethalin 1.0 kg ha [1] (PE); and it were at par with pendimethalin 1 kg ha^{-1} (PE) fb imazethapyr 75 g ha^{-1} (PoE), quizalofop- ethyl 50 g ha^{-1} (PoE), quizalofop- ethyl 60 g ha^{-1} (PoE) and imazethapyr 75 g ha^{-1} (PoE). However, weed free situation showed superiority over herbicidal treatments with respect to density and dry weight of weeds; and growth and yield of field pea.

Keywords: Field pea, herbicide, weeds, weed control efficiency, yield

Pulses are the cheapest and important source of dietary protein for human. It also plays a vital role in improving soil health by biological nitrogen fixation and adding huge amounts of organic matter (Anon. 2006). Among pulses, field pea (*Pisum sativum* L.) is an important food legume, which is grown for green pods making vegetables and dry seeds for *dhal*, preparing soups, stews and various cuisines. In India it is cultivated in 0.78 mha with the annual production of 0.71 mt and share 3.1 per cent of area and in total pulse production. Among the pea growing states U.P. ranks first in area (0.413 mha) and production (0.483 mt) followed by Haryana and Madhya Pradesh (Anon., 2011). The grains are excellent source of protein (22.5%), carbohydrate (61.5%) and vitamins, which is good for human and livestock consumption. Weeds are the major threats in field pea which limits the productivity. Weed competition is a serious limitation in field pea, because it is less competitive to weeds due to its initial slow growth and short stature resulting in huge yield loss (Chaudhary *et al*., 2009). Veres and Tyr (2012) reported that weed competition throughout the crop season resulted in the reduction of grain yield up to 65.8%. For the control of weeds generally farmers adopted manual weeding (Singh and Wright, 2006). But due to increases labour cost and scarcity of labour, manual weeding become a difficult task in field pea, which force them for opting alternative, cheaper and easier method of (chemical) weed control. Pre-emergence application of pendimethalin 1.0 kg ha^{-1} proved effective in reducing density and dry matter production of weeds resulted higher yield attributes and seed yield of field pea (Govardhan *et al*., 2007). Recently some of the post-emergence herbicides such as quizalofop, imazethapyr have been found effective in controlling weeds in field pea. Thus, there is need to evaluate the effectiveness of pre -emergence herbicides alone or in a combination with the post-emergence in field pea. Taking into consideration the above facts in mind and the availability of new herbicides, it becomes imperative to find out the suitable herbicide for controlling weeds in field pea. Thus, keeping the above facts in view the present study was carried out to evaluate the efficacy of herbicides on weeds and yield of field pea under irrigated condition.

MATERIALS AND METHODS

The experiment was conducted during the *rabi* seasons of 2010-2011 at the pulse block, Agricultural Research Farm, I.Ag.Sc., BHU, Varanasi, Uttar Pradesh to evaluate the efficacy of herbicides on weeds and yield of field pea under irrigated condition. The soil of the experimental field was sandy clay loam in texture, with slightly alkaline in reaction (pH 7.8). It was moderately fertile, being low in available organic carbon (0.45 %), available nitrogen (163 kg ha^{-1}), and available phosphorus (39 kg ha^{-1}) and potassium (297 kg ha^{-1}).The experiment was laid out in randomized block design (RBD) with three replication. The experiment comprised 10 weed control treatments viz., weed free (H W at 30 and 60 DAS), pendimethalin 1.0 kg ha [1] as pre-emergence (PE), pendimethalin 1.0 kg as pre-emergence (PE) *fb* imazethapyr 75 g ha [1] as post-emergence (PoE), quizalofop- ethyl 60 g ha [1] as post-emergence (PoE), quizalofop- ethyl 50 g ha [1] as post-emergence (PoE), imazethapyr 75 g ha [1] as post-emergence (PoE), imazethapyr 50 g ha [1] post-emergence (PoE), chlorimuron- ethyl 4 g ha [1] as pre-

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plant incorporation (PPI), T_9: pendimethalin 1kg ha ^{1} as pre-emergence (PE) + imazethapyr 50 g ha ^{1} as post-emergence (PoE), were compared with weedy check. Field pea variety 'HUDP-15' was sown at row spacing of 30 cm apart on 11 November 2010. Full dose of nitrogen, phosphorus, potassium, sulphur, and zinc were applied as basal (20+60+20+20+5 kg NPKS and Zn ha^{-1}). The crop was raised as per the standard agronomic package of practices. Herbicides were applied by Knapsack Sprayer using 500 litter of water ha^{-1}. Two manual weeding were done at 30 and 60 DAS by using spud. Weed population was recorded in weedy check plot at 60 DAS to work out the relative density of weed. The biometric observation of plant sample was taken at 60 DAS, yield attributes and yield was recorded at the harvest of crop. Collected data was statistically analyzed as per procedure to draw a valid conclusion. Weed index (WI) and weed control efficiency (WCE) were worked out using following formulae

$$WI = \frac{X - Y}{X} \times 100$$

$$WCL = \frac{DMC - DMT}{DMC} \times 100$$

where, X = Grain yield from weed free plot, Y = Grain yield from treated plot
DMC = Dry matter production of weeds m^{-2} in control plot, DMT = Dry matter production of weed m^{-2} in treated plot.

Weed flora

The predominant weed species infesting the crop at 60 DAS were *Cyperus rotundus* L. (35.3%), *Chenopodium albu*m L. (14.1%), *Parthenium hysterophorus* L. (23.5%), *Melilotus alba* L. (7.0%), *Solanum nigrum* L. (11.8%), *Anagallis arvensis* L. (5.9%), Vicia *sativa* L. (2.4%) and *Phalaris minor* (2.15%). Similar weed flora in field pea reported by Bhyan *et al*. (2004).

Density and dry weight of weed

Among herbicidal treatments, application of pendimethalin 1kg ha^{-1} (PE) *fb* imazethapyr 50 g ha^{-1} (at 20 DAS PoE) was significantly reduced density and dry weight of weed over imazethapyr 50 g ha^{-1}(PoE), chlorimuron- ethyl 4 g ha ^{1}(PPI) and pendimethalin 1 kg ha ^{1}(PE) and it were at par with pendimethalin 1 kg ha^{-1} *fb* imazethapyr 75 g ha^{-1}, quizalofop- ethyl 50 g ha^{-1}(PoE), quizalofop- ethyl 60 g ha^{-1} and imazethapyr 75 g ha^{-1}(Table 1). None of the treatments were comparable to weed free (HW 30 and at 60 DAS) controlling weeds. However, all the herbicides were significantly superior to weedy check. The main reason of reducing density and dry weight of weeds under sequential application of herbicides because first flush of weeds were controlled by pendimethalin applied as PE and the second flush of weeds was controlled by imazethapyr applied as PoE and due to broad spectrum properties of these herbicides. Similar results also reported by Butter *et al*. (2008) and Dawson *et al*. (2007).

Weed control efficiency

Amongst, herbicidal treatments pendimethalin 1kg ha^{-1} (PE) *fb* imazethapyr 50 gha^{-1} (PoE) recorded highest weed control efficiency (89.1%) over other herbicidal treatments (Table 1). The reason of highest WCE can be attributed to its effective control of all types of weeds. These findings are close conformity with research result of Rana *et al*. (2004).

Weed index

The lowest weed biomass was recorded under pre-emergence application of pendimethalin 1kg ha^{-1} *fb* imazethapyr 50 g ha^{-1} as PoE resulted lowest weed index (8.82%) then the other herbicidal treatments. Maximum weed index were recorded under weedy check (29.20%). These results are corroborated with the findings of Johnson and Holm (2010). Sharma and Singh (2005) stated that hand weeding at 30 and 60 DAS in pea recorded lowest weed index.

Growth attributes

All the growth parameters *i.e*. plant height , dry weight $plant^{-1}$, branches $plant^{-1}$, no. of nodules $plant^{-1}$ and nodule dry weight were significantly higher under pre –emergence application of pendimethalin 1kg ha^{-1} *fb* imazethapyr 50 g ha^{-1} over imazethapyr 50 g ha ^{1} (PoE), chlorimuron- ethyl 4 g ha ^{1} (PPI) and pendimethalin 1.0 kg ha ^{1} (PE) and it were at par with the treatment pendimethalin 1 kg ha^{-1} *fb* imazethapyr 75 g ha^{-1}, quizalofop- ethyl 50 g ha^{-1}, quizalofop- ethyl 60 g ha^{-1} and imazethapyr 75 g ha^{-1} (Table 1and 2). This was due to reduces weed competition in crop under herbicidal treatments. Hand weeding not only favoured the crop growth with abundant availability of moisture, nutrients, light and space, but also reduced over all weed interference, facilitating vigorous growth and development of crop plants. These results are in close conformity with the findings of Singh *et al*. (2008).

Yield attributes and yield

A perusal of data presented in table 2 indicates that among the herbicidal treatments application of pendimethalin 1kg ha^{-1} *fb* imazethapyr 50 g ha^{-1} (PoE) recorded significantly the highest number of pods plant^{-}

Table 1: Influence of weed management practices on weed density, weed dry weight, weed control efficiency, weed index and growth attributes of irrigated field pea

Treatment	Total weed density at 60 DAS (m^{-2})	Total weed dry weight at 60 DAS(g m^{-2})	Weed control efficiency (%)	Weed index (%)	Plant height at harvest(cm)	Dry weight $plant^{-1}$ at harvest(g)	Branches $plant^{-1}$ at 90 DAS
T_1	0.00	0.00	100.0	0	95.00	29.12	4.56
T_2	69.33	42.09	29.7	23.44	82.43	19.48	3.69
T_3	28.67	11.25	81.2	10.19	89.44	25.26	4.30
T_4	36.67	12.70	78.8	14.62	87.48	24.43	4.23
T_5	40.32	13.00	78.3	19.05	86.62	22.29	4.02
T_6	43.98	14.10	76.4	19.70	87.25	23.16	4.18
T_7	52.66	35.42	40.8	26.85	84.74	21.28	3.93
T_8	57.33	40.90	31.7	27.68	84.28	20.67	3.80
T_9	25.66	6.50	89.1	8.44	89.41	25.31	4.39
T_{10}	78.00	59.85	0.0	37.10	73.45	16.86	3.34
SEm (±)	**6.11**	**2.90**	**-**	**-**	**0.97**	**1.023**	**0.13**
LSD(0.05)	**18.32**	**7.75**	**-**	**-**	**5.46**	**3.01**	**0.37**

Note: T_1 -Weed free (H W at 30 and 60 DAS), T_2 – Pendimethalin 1.0 kg ha ^{1} (PE), T_3 – Pendimethalin 1.0 kg (PE) fb imazethapyr 75 g ha ^{1} (PoE), T_4 " Quizalofop- ethyl 60 g ha ^{1} (PoE), T_5 "Quizalofop- ethyl 50 g ha ^{1} (PoE), T_6 "Imazethapyr 75 g ha ^{1} (PoE), T_7 " Imazethapyr 50 g ha ^{1} (PoE), T_8 " Chlorimuron- ethyl 4 g ha ^{1} (PPI), T_9 " Pendimethalin 1kg ha ^{1} (PE) fb imazethapyr 50 g ha ^{1} (PoE), T_{10} " Weedy check

Table 2: Yield attributes, yield and harvest index of irrigated field pea under different weed management practices

Treatment	No. of nodules $plant^{-1}$ at 60 DAS	Nodule dry weight at 60 DAS (mg $plant^{-1}$)	No. of pods $plant^{-1}$	No. of grains pod^{-1}	100-seed weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index (%)
T_1	37.70	21.63	21.01	6.41	22.04	2167.0	6487.0	25.0
T_2	33.48	18.7	12.00	5.05	14.77	1659.0	5058.0	24.4
T_3	36.76	20.34	18.93	5.88	17.50	1946.0	6056.0	24.3
T_4	35.81	20.11	17.98	5.75	15.99	1850.0	5900.0	23.9
T_5	35.69	20.7	16.98	5..66	16.06	1754.0	5750.0	23.4
T_6	34.84	20.9	17.79	5.72	15.58	1740.0	5546.0	23.9
T_7	33.87	19.76	15.43	5.24	15.60	1585.0	5275.0	23.1
T_8	33.51	18.72	12.00	6.08	15.46	1567.0	5200.0	23.2
T_9	36.97	21.84	19.31	5.50	17.95	1984.0	6150.0	24.7
T_{10}	29.54	17.76	10.84	3.77	13.06	1363.0	3516.0	22.9
SEm (±)	**0.69**	**0.36**	**0.82**	**0.80**	**0.74**	**83.0**	**202.0**	**0.75**
LSD(0.05)	**2.06**	**1.06**	**2.44**	**0.25**	**2.29**	**245.0**	**605.0**	**N.S**

Note: T_1 -Weed free (H W at 30 and 60 DAS), T_2 – Pendimethalin 1.0 kg ha ^{1} (PE), T_3 – Pendimethalin 1.0 kg (PE) fb imazethapyr 75 g ha ^{1} (PoE), T_4 " Quizalofop- ethyl 60 g ha ^{1} (PoE), T_5 "Quizalofop- ethyl 50 g ha ^{1} (PoE), T_6 "Imazethapyr 75 g ha ^{1} (PoE), T_7 " Imazethapyr 50 g ha ^{1} (PoE), T_8 " Chlorimuron- ethyl 4 g ha ^{1} (PPI), T_9 " Pendimethalin 1kg ha ^{1} (PE) fb imazethapyr 50 g ha ^{1} (PoE), T_{10} " Weedy check

^{1} (10.84), grains $pods^{-1}$ (6.08), seed weight (17.95 g), grain yield (1984 kg ha^{-1}) and straw yield (6150 kg ha^{-1}) as compared to imazethapyr 50 g ha ^{1} (PoE), chlorimuron- ethyl 4 g ha ^{1} (PPI) and pendimethalin 1.0 kg ha ^{1} (PE) and it were at par with pendimethalin 1 kg ha^{-1} *fb* imazethapyr 75 g ha^{-1}, quizalofop- ethyl 50 g ha^{-1}, quizalofop- ethyl 60 g ha^{-1} and imazethapyr 75 g ha^{-1}. Weed free (HW at 30 and 60 DAS) recorded

significantly the highest pods plant^{-1} (21.01), grains pods^{-1} (6.41), seed weight (22.04 g), grain (2167 kg ha^{-1}) and straw yield (6487 kg ha^{-1}) and harvest index (25.0%) over herbicidal treatments. However, all the herbicidal treatments were significantly superior over weedy check. Higher yield attributes under herbicidal treatments may be due to lesser crop-weed competition, which gave better environment for crop growth and development of crop. The minimum grain and straw yields were recorded under weedy check due to more weed infestation resulted poor crop growth and poor performance of yield attributing characters. These results are corroborated with the research results of Bhyan *et al*. (2004) and Rajeev *et al*. (2006)

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