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Weed management in field pea (*Pisum sativum* L.) under vertisols condition of Chhattisgarh

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Abstract
An experiment was conducted at DKS College of Agriculture and Research Station, Bhatapara, Chhattisgarh to judge the profitability and suitability to different weed management in field pea clay loam soil. Experiments with 12 different treatment combination indicates that depends upon the availability of labour, profitability of rabi field pea could be achieved through 2 hand weeding 20 and 40 days after sowing. The study also reveals that application of, Pendimenthalin 30% EC @ 1000 g ha^{-1} (PE), Oxyfluorfen 23.5% EC @ 200 g ha^{-1} (PE), Pendimenthalin 30% EC @ 1000 g ha^{-1} (PE)+ Hand weeding 30DAS, Imazethapyr 10% SL @ 75 g ha^{-1} (PoE), Quizalofop-p-ethyl 5% EC @ 75 g ha^{-1} (PoE), Fenoxaprop-p-ethyl 9.3% EC @ 100 g ha^{-1} (PoE), Pendimenthalin 30% EC @ 1000 g ha^{-1} (PE)- Imazethapyr10% SL @ 75g ha^{-1} (PoE), Imazethapyr 35% + Imazamox 35% WG @ 70 g ha^{-1} (PoE), Pendimenthalin 30% EC @ 1000 g ha^{-1} (PE) - Imazethapyr 35% + Imazamox 35% WG @ 70g ha^{-1} (PoE),

Keywords: Field pea (*Pisum sativum* L.), weed, herbicides, profitability, productivity

Introduction
Pulses are 2nd important cultivated crops after cereals. Avariety of pulse crops grown in India and world. Among the crops the major ones are gram, pigeon pea, lentil and field pea etc. Pulses crops are grown across the country as sole crop, intercrop, mixed crop, catch crop, relay crop and utera crop, depending upon the agro climatic conditions of the place where they are cultivated. Field pea (*Pisum sativum* L.) is primarily used for human consumption or as a livestock feed. Field pea is highly nutritive contains high percentage of protein (6.2 g $100g^{-1}$) and carbohydrate (16.9g/100g of fresh wt.) with minerals and vitamins A, B and C (Makasheva 1983) [6]. It is well understood that weeds interfere with crop growth and reduce yield and quality either throughout the competition for light, food, water, nutrients and space, allelopathic effect or harbour insects and diseases (Dittmar and Boyd 2015) [5]. Weeds are big constraints in crop production and responsible for heavy yield losses. The available herbicides *viz*., Pendimenthalin, Oxyfluorfen, Imazethapyr, Quizalofop-p-ethyl, Fenoxaprop- p-ethyl, Imazethapyr + Imazamox pre mix are able to check the emergence and growth of annuals grasses and broad leaved weeds. This study was carried out to evaluate the efficiency of different pre-and post-emergence herbicides when applied alone or in combination with cultural operation in field pea.

Materials and Methods
The field experiment was conducted in the form of DKS College of Agriculture and Research Station, Bhatapara, Chhattisgarh in *rabi* season of 2020-21 to evaluate weed management in field pea. The experimental soil was clay loam in texture and slightly alkaline with pH 8.0 and EC 0.20 dS^{-1}. It was low available nitrogen (113.8 kg ha^{-1}), medium available phosphorus (12.72 kg ha^{-1}) and high in available potassium (384 kg^{-1}). The range of mean maximum and minimum temperature 9.2 to 10.3 ºC and 35.2 to 38.4 ºC during the crop growth and development period was respectively. The range of the relative humidity 28.9% - 81.4%, bright sun shine 1.9 to 6.8 hrs day^{-1}, wind speed 2.1 to 4.8 km hr^{-1} and daily evaporations 3.1 to

6.8 mm was respectively. The experiment comprised 12 treatments *viz.*, T_1:Weed check, T_2: hand weeding (20 & 40 DAS), T_3: Pendimenthalin 30% EC @ 1000 g ha^{-1} (PE), T_4: Oxyfluorfen 23.5% EC @ 200 g ha^{-1} (PE), T_5: Pendimenthalin 30% EC @ 1000 g ha^{-1} (PE)+ Hand weeding 30DAS, T_6: Imazethapyr 10% SL @ 75 g ha^{-1} (PoE), T_7: Quizalofop-p-ethyl 5% EC @ 75 g ha^{-1} (PoE),T_8:Fenoxaprop-p-ethyl 9.3% EC @ 100 g ha^{-1} (PoE),T_9 Pendimenthalin 30% EC @ 1000 g ha^{-1} (PE) - Imazethapyr10% SL @ 75g ha^{-1} (PoE), T_{10}: Imazethapyr 35% + Imazamox 35% WG @ 70 g ha^{-1} (PoE), T_{11}: Pendimenthalin 30% EC @ 1000 g ha^{-1} (PE) - Imazethapyr 35% + Imazamox 35% WG @ 70g ha^{-1} (PoE), and T_{12}: weed free, were replicated thrice in randomized block design. The field variety paras was sown on November 12, 2020 at row spacing 30 cm using seed rate 100 kg^{-1}. The gross and net plot size was 6 × 5 m and 5.40 × 4.80 m, respectively. The entire dose of fertilizer *i,e*, the starter dose of nitrogen 20 kg^{-1}, phosphorus 50 kg^{-1}, and potassium 30 kg^{-1} was applied at the time of sowing through urea, SSP and MOP, respectively. Pendimethalin and Oxyfluorfen was applied next day of sowing whereas Imazethapyr, Quizalofop, Fenoxaprop and odyssey were applied at 30 DAS. Snow–melt water, the only source of irrigation was used to irrigate field pea through sprinklers, and rain gun. The crop was harvested on 5th march 2021. Other practices were in accordance with the recommended package for the region.

Weed density, dry matter accumulations. yield attributes, green pod yield, productivity, cost of cultivation, gross returns, net returns, B:C ratio and profitability were recorded or computed after the harvested of the crop. Weed control efficiency and weed index were worked out using the following formula:

$$\text{WCE (\%)} = \frac{\text{Weed dry weight in control plot - Weed dry weight in treated plot}}{\text{Weed dry weight in treated plot}} \times 100$$

$$\text{Weed index} = \frac{(x-y)}{X} \times 100$$

Where, X = yield from weed free plot. Y = yield of particular treatment plant.

Results and Discussion

The experiment field was heavily infested with different weed flora. *Phalaris minor* (L.). The predominant sedges was *Cyperus rotandus* (L.) Whereas, the *Parthenium hysterophorus* (L.) was the pre dominant broad leaved weeds followed by *Medicago denticulata* (L.), *Chenopodium album* (L.), *Anagallis arvensis* and *Vicia sativa* (L.). Similar weed flora in the field pea field has also been reported by Kumar *et al*, 2015; Rana *et al*, 2004 [8, 11].

The results revealed that different weed management practices exerted significant influence on growth and yield of field pea (Table 2). The treatment T_{12} (Weed free) significantly enhanced growth and yield attributes *viz*., plant height, branches $plant^{-1}$,pod $plant^{-1}$, seed pod^{-1}, seed weight $plant^{-1}$ and 100-seed weight, and ultimate increased seed yield and stover yields, however it was found statistically at par with the treatments T_2(2 hand weeding 20 and 40 DAS), T_{11}: Pendimenthalin 30% EC @ 1000 g ha^{-1} (PE) - Imazethapyr 35% + Imazamox 35% WG @ 70g ha^{-1} (PoE), T_10: Imazethapyr 35% + Imazamox 35% WG @ 70 g ha^{-1} (PoE), T_6: Imazethapyr 10% SL @ 75 g ha^{-1} (PoE),T_8:Fenoxaprop-p-ethyl 9.3% EC @ 100 g ha^{-1} (PoE), where the treatment T_1(weedy check), registered significantly the lowest growth and yield of the crop. The lowest crop weed competition was noticed T_2 (2 hand weeding 20 and 40 DAS) followed by Pendimenthalin 30% EC @ 1000 g ha^{-1} (PE) - Imazethapyr 35% + Imazamox 35% WG @ 70g ha^{-1} (PoE) throughout the growth stage crop and created favourable environment for plant growth. Thus enhance availability of nutrient, water, light and space, which might have accelerated the photosynthesis rate, thereby increasing the supply of carbohydrates leading to increase in growth and yield. These finding are in agreement with those of Ved *et al.* (2000) [3]. Rana *et al*. (2013) [1], Different weed control treatment significantly influenced weed density recorded I 30, 60 and 90 DAS, (Table 1).

Table 1: Intensity and dry weight of weeds under different weed management practices in field pea

Treatment	Total weed density(No. m^{-2})			Total dry matter accumulation (kg m^{-1})			WCE (%)	WI (%)
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS		
T_1	12.9 (166)	13.4 (181)	11.2 (126)	5.14 (26.1)	7.15 (53.2)	11.90 (141)	0.00	57.0
T_2	4.61 (20.7)	4.06 (16.0)	3.63 (12.6)	2.70 (6.80)	4.20 (17.2)	3.91 (14.7)	90.5	2.98
T_3	7.39 (54.1)	6.50 (41.8)	6.10 (36.8)	3.68 (13.0)	4.78 (22.3)	7.71 (32.1)	72.4	39.4
T_4	7.76 (59.7)	6.62 (43.4)	7.0 (48.6)	3.83 (14.1)	4.94 (24.2)	6.48 (41.4)	69.7	40.7
T_5	6.96 (47.8)	6.12 (36.9)	5.92 (34.6)	3.59 (12.4)	4.65 (43.7)	6.08 (36.5)	79.1	35.3
T_6	5.84 (33.6)	5.32 (27.8)	4.80 (22.5)	3.38 (10.9)	4.21 (21.7)	4.75 (22.0)	87.1	20.7
T_7	6.48 (41.5)	5.97 (35.2)	5.68 (31.8)	3.65 (12.8)	6.07 (36.8)	5.86 (33.8)	80.9	27.3
T_8	6.31 (39.3)	5.64 (31.3)	5.27 (27.3)	3.44 (11.3)	5.65 (31.8)	5.12 (25.8)	83.7	24.8
T_9	7.08 (49.5)	5.91 (34.4)	6.84 (46.3)	3.51 (11.8)	4.72 (21.9)	5.23 (26.7)	76.0	35.7
T_{10}	5.38 (28.4)	6.20 (37.9)	4.11 (16.4)	(16.9)	3.95 (15.0)	4.13 (16.5)	90.0	19.2
T_{11}	5.02 (24.7)	4.49 (19.7)	4.25 (17.6)	3.11 (9.1)	4.19 (17.1)	4.06 (16.0)	90.3	12.7

T_{12}	0.0	0.0	0.0	0.0	0.0	0.0	100	0
S.E(m)±	0.20	0.14	0.10	0.07	0.35	0.15	1.821	1.242
CD (*P*=0.05)	0.60	0.40	0.30	0.20	1.03	0.44	5.206	3.550

All the weed management treatment significantly reduced the weed density compare to weedy check. Next to the weed free T_{12}, followed by 2 hand weeding (30 and 40 DAS), Pendimenthalin 30% EC @ 1000 g ha^{-1} (PE) - Imazethapyr 35% + Imazamox 35% WG @ 70g ha^{-1} recorded significantly lowest weed density which remained statically at par with the treatments T_10: Imazethapyr 35% + Imazamox 35% WG @ 70 g ha^{-1} (PoE), T_6: Imazethapyr 10% SL @ 75 g ha^{-1} (PoE), Dry weight of weeds was significantly influenced due to different weed management practices (Table 1). Beside theT_1 (weed free) the lowest dry weight of weeds was observed under the treatment T_2 (2 hand weeding 20 and 40 DAS) through it was found at par with the treatment T_{11} Pendimenthalin 30% EC @ 1000 g ha^{-1} (PE) - Imazethapyr 35% + Imazamox 35% WG @ 70g ha^{-1}. Significantly the highest dry weight of weed was observed under the treatment T_1 weedy check, Reduction in dry weight of weeds under the treatmentsT_2 hand weeding 20 and 30 DAS (90.5%). The might be attributes to the effective control of weeds under this treatments. The weedy check T_1 recorded significantly highest weed dry weight owing to uncontrolled condition favoured luxurious weed growth leading to increased weed dry matter. Halker *et al*. (2001a) [7] also reported 44% yield loss in pea due to weeds in USA.

Table 2: Effect of different weed management treatments on plant growth and seed yield parameters of field pea

Treatment	Plant height(cm)	Pod plant^{-1}	Seed pod^{-1}	100-seed weight (g)	Seed yield (q ha^{-1})	Stover yield (q ha^{-1})
T_1	49.15	11.38	3.86	14.43	690.0	2734.06
T_2	64.40	28.71	4.89	15.89	1558.0	3461.60
T_3	54.23	17.40	4.55	15.17	979.0	2866.03
T_4	49.50	14.63	4.46	15.16	952.0	2826.02
T_5	56.91	22.46	4.66	15.47	1032.0	2982.62
T_6	58.58	26.46	4.81	15.73	1207.0	3154.27
T_7	57.19	24.32	4.54	15.55	1166.0	3038.27
T_8	58.22	24.60	4.79	15.67	1172.0	3051.97
T_9	56.22	21.51	4.43	15.27	1029.0	2934.80
T_{10}	59.59	28.25	4.84	15.80	1297.0	3186.68
T_{11}	62.87	27.40	4.85	15.86	1401.0	3247.12
T_{12}	68.16	29.49	5.36	16.22	1606.0	3732.58
S.E(m)±	0.16	3.50	0.10	0.07	29.16	4.83
CD (P=0.05)	0.48	10.26	0.28	0.20	85.53	14.16

A perusal of data presented in table 1 indicates that besides the weed free T_{12}, weed free maximum WCE was obtained under the treatment T_2 (2 hand weeding 20 and 40 DAS), followed by treatment T_{11} Pendimenthalin 30% EC @ 1000 g ha^{-1} (PE) - Imazethapyr 35% + Imazamox 35% WG @ 70g ha^{-1}, minimum WI was obtained with the treatment T_2 (2 hand weeding 2o and 40 DAS). This might be due to estimation of weed by hand weeding and herbicides. These finding are in close conformity with those reported by Nagi *et al*. (2001) [9], Bharat *et al*. (2006) [10] and Kumar and Singh (2014) [8].

Conclusion

It is concluded from the present investigation the weed free treatment (T_{12}) was the most effective for controlling weeds and obtaining higher seed yield and quality in field pea cv. Bhatapara (Chhattisgarh) conditions but B:C ratio is very low as compared to T_2 and T_{10}. Through the B:C ratio of T_2 is maximum but seed yield and quality in this treatment are significantly lower than T_{12} while treatment T_{12} is at par with T_2 in the quality and yield parameters with higher economic returns. Therefore 2 hand weeding at 20 and 40 DAS (T_2) followed by is recommended for pea weed management to obtain higher seed yield and quality with high B:C ratio (2.52) and less chemical use.

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