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# Chemical weed control in potato under mid hill conditions of Himachal Pradesh

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## Abstract

**Eight treatments *viz.* paraquat 0.50 kg ha$^{-1}$ (before crop emergence), mulching, metribuzin 0.5 kg ha$^{-1}$ followed by (fb) earthing up, pendimethalin 1.0 kg ha$^{-1}$ fb earthing up, prometryne 1.0 kg ha$^{-1}$ fb earthing up, earthing up, hand weeding twice and weedy check were evaluated for weed control, yield and economics on silty clay loam soil during 2005 and 2006 at Palampur. Paraquat, metribuzine fb. earthing up, prometryn fb. earthing up, earthing up and handweeding twice significantly controlled *Phalaris minor, Avena ludoviciana, Lolium temulentum, Vicia* sp. and *Anagallis arvensis. Coronopus didymus* appeared after paraquat application was not significantly controlled by it. Metribuzin fb earthing up, prometryn fb earthing up, pendimethalin (PE) fb. earthing up, paraquat and hand weeding twice increased potato tuber yield by 31.1, 32.6, 25.0, 18.7 and 17.0%, respectively over farmer's practice (earthing up) and by 131.0, 133.6, 120.3, 109.2 and 106.1%, respectively over weedy check. Prometryn fb. earthing up resulted in highest gross and net returns due to weed control. Paraquat gave higher marginal benefit cost ratio. Mulching was least economically viable.**

**Key words**: Paraquat, potato, integrated, metribuzin, prometryn and earthing up.

## Introduction

A potato crop planted during winter takes long time for emergence (40-55 days) and has slow initial growth. Therefore, it faces a severe weed infestations right from the beginning. Its heavy demand for nutrients and water further provides congenial conditions for the growth of weeds. Depending upon ecological conditions, yield losses in potato due to weeds have been estimated from 10 to 80% (Lal and Gupta, 1984, Kumar *et. al.* 2008 and Singh *et al,* 2005). Hand weeding and hoeing are the common practices to tackle weed menace in mid hill conditions of Himachal Pradesh. However, timely weed control using manual methods may not be possible due to non-availability of labour and high rate of wages during peak period of farm operations. Hence chemical weed control appears to hold a great promise in dealing with effective, timely and economic weed suppression. It also results in better crop performance and improved yield of tubers than manual and mechanical means due to the elimination of mechanical damage of the plants. However, integrated weed management (IWM) is always advantageous over manual or chemical methods (Khan *et al.*, 2008). Keeping all these points in view, the present investigation was carried out to study the efficacy of different herbicidal treatments in integration with mechanical methods to control weeds in potato.

## Materials and Methods

The field investigation was carried out during the winter seasons of 2005 and 2006 at Palampur (1280 m altitude, 32°6′N latitude and 76°3′E longitude). The soil of the experimental site was silty clay loam in texture, acidic in reaction and medium in available N (232 kg ha$^{-1}$), P (18.2 kg ha$^{-1}$) and K (181.1 kg ha$^{-1}$) contents. Eight treatments *viz.* paraquat 0.5 kg ha$^{-1}$ (when the potato emergence was not more than 5%), 5 cm thick mulching (*Chromolaena*), metribuzin 0.5 kg ha$^{-1}$ pre-emergence (PE) fb earthing up, pendimethalin 1.0 kg ha$^{-1}$ (PE) fb earthing up,

prometryn 1.0 kg $ha^{-1}$ (PE) fb earthing up, one earthing up, hand weeding twice at 60 and 90 days after planting ( DAP) and weedy check were tested in randomized block design with three replications. Earthing up was carried out at 60 DAP. Herbicides were applied with backpack power sprayer using 600 l water $ha^{-1}$. Metribuzin, pendimethalin and prometryn were sprayed immediately after planting potatoes. Potato variety of Kufri Jyoti was planted on 18 January 2005 and 10 January 2006 and harvested on 31 May 2005 and 15 May 2006. One deep ploughing with soil turning plough followed by 2-3 ploughings with a country plough or harrow were carried out to prepare seed bed for potato. The crop was fertilized with 120 kg N, 80 kg $P_2O_5$ and 60 kg $K_2O$ through urea, single superphosphate and muriate of potash, respectively. Full amount of phosphorus, potash and half of nitrogen was applied at sowing time in furrows and covered partially with soil and then tubers were planted so that the tubers do not come in direct contact with the fertilizers. The remaining half nitrogen was top dressed at the time of first earthing up. Count of weeds was recorded at 90 DAP and at harvest. The count data were analyzed after subjecting the original data to square root transformation ($\sqrt{x+1}$). Dry weight of weeds was recorded at harvest. Yields were harvested from net plot (4.2 m x 3.0 m). Economics was worked out based on prevalent market prices.

## Results and Discussion

### Effect on weeds

The predominant weeds in the experimental field were *Phalaris minor, Avena ludoviciana, Lolium temulentum, Vicia sativa, Anagallis arvensis,* and *Cornopus didymus.* However, towards the maturity of crop *Alopecurus myosuriodes, Bidens pilosa, Ageratum conyzoides* and *Echinochloa colona* were also found.

All treatments were significantly superior to weedy check in reducing the count of *Phalaris minor* both at 90 DAP and at harvest in 2005 and 2006, (Table 1). Hand weeding twice resulted in significantly lower count of *Phalaris minor* at 90 DAP. These findings are in conformity with those of Kumar *et. al.* (2007). Paraquat, metribuzin, prometryn fb. earthing up during 2005 and pendimethalin fb earthing up and one earthing up during 2006 were equally effective as hand weeding twice for the control of *Phalaris minor* until digging / harvesting of potatoes. Hand weeding, one earthing up, paraquat, pendimethalin/ prometryn fb. earthing up and metribuzin were equally good in reducing the population of *Avena ludoviciana* during 2005 and 2006. All the treatments had almost completely suppressed *Lolium* at 90 DAP during 2006.

Handweeding twice, metribuzine, prometryn fb. earthing up, pendimethalin fb. earthing up, earthing up and paraquat effectively reduced the population of *Vicia sp.* during 2005 (Table 2). All treatments except paraquat were effective against *Coronopus didymus.* This weed appears late therefore escapes paraquat injury since it is a non residual herbicide. All the treatments effectively controlled *Anagallis arvensis.*

The species wise reduction in the population of weeds, also resulted in significant decrease in total weed population and dry matter accumulation (Table 3). Hand weeding twice remaining at par with prometryn fb. earthing up during 2005 resulted in significantly lower total weed population at 90 DAP in 2005 and 2006. Metribuzin, pendimethalin and prometryn each followed by earthing up were equal to earthing up in reducing total weed population. Hand weeding twice remaining at par with pendimethalin fb. earthing up, metribuzin fb. earthing up and paraquat resulted in significantly lower total weed dry matter accumulation at 90 DAP in 2005. However, all treatments except paraquat were at par with hand weeding twice in reducing the total weed dry matter accumulation in 2006.

### Effect on crop

The superior weed control in early stages of crop growth with different treatments resulted in significantly higher potato tuber yield over weedy check (Table 3). Metribuzin followed by earthing up and prometryn fb. earthing up remaining at par with pendimethalin fb. earthing up, paraquat and hand

**Table 1. Effect of treatments on population of grassy weeds $m^{-2}$ at 90 DAP in potato**

| Treatment | Rate (kg $ha^{-1}$) | Time of application | Species wise weed population $m^{-2}$ | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | *Phalaris* | | | | *Avena* | | *Lolium* | |
| | | | 90 DAP | | At harvest | | 90 DAP | | 90 DAP | |
| | | | 2005 | 2006 | 2005 | 2006 | 2005 | 2006 | 2005 | 2006 |
| Paraquat | 0.5 | Before crop emergence | 2.2(4.0) | 3.2(9.3) | 1.4(1.3) | 2.4 (5.3) | 1.4(1.3) | 1.0(0.0) | 1.0(0.0) | 1.0(0.0) |
| Mulching | 5 cm | Immediately after planting | 4.3(18.6) | 3.9(14.6) | 1.0(0.0) | 2.7 (8.0) | 3.6(13.3) | 2.9(8.0) | 1.6(2.6) | 1.4(1.3) |
| Metribuzin fb earthing up | 0.5 | Pre emergence | 2.7(6.6) | 1.8(2.6) | 1.8(4.0) | 1.6 (2.6) | 1.8(4.0) | 1.6(2.6) | 1.0(0.0) | 1.0(0.0) |
| Pendi. fb earthing up | 1.0 | Pre emergence | 3.3(10.6) | 2.5(6.6) | 2.4(6.6) | 1.0 (0.0) | 1.4(1.3) | 1.0(0.0) | 1.0(0.0) | 1.4(1.3) |
| Prometryn fb earthing up | 1.0 | Pre emergence | 2.4(5.3) | 2.9(8.0) | 1.4(1.3) | 2.0 (4.0) | 1.8(2.7) | 1.0(0.0) | 1.0(0.0) | 1.4(1.3) |
| Earthing up | Once | 60 DAP | 4.1(17.3) | 2.5(6.6) | 3.7(13.3) | 2.3 (5.3) | 1.0(0.0) | 1.0(0.0) | 1.0(0.0) | 1.0(0.0) |
| Hand weeding | Twice | 60 & 90 DAP | 1.6(2.6) | 1.0(0.0) | 3.0(10.6) | 2.0 (4.0) | 1.0(0.0) | 1.0(0.0) | 1.0(0.0) | 1.0(0.0) |
| Unweeded | - | - | 8.5(72.0) | 8.4(70.6) | 6.7(38.6) | 4.9(24.0) | 3.7(13.3) | 4.3(18.6) | 1.6(2.6) | 2.9(8.0) |
| LSD (P=0.05) | - | - | 1.7 | 1.5 | 1.9 | 1.7 | 1.5 | 0.9 | NS | 0.9 |

Data transformed to $\sqrt{x+1}$ root transformation; Values in the parentheses are the means of original values.

**Table 2. Effect of treatments on population of broadleaved weeds $m^{-2}$ in potato at harvest**

| Treatment | Rate (kg $ha^{-1}$) | Time of application | Species wise weed population $m^{-2}$ | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | *Cornopus* | | | | *Vicia* | | | | *Anagallis* | | | |
| | | | 90 DAP | | At harvest | | 90 DAP | | At harvest | | 90 DAP | | At harvest | |
| | | | 2005 | 2006 | 2005 | 2006 | 2005 | 2006 | 2005 | 2006 | 2005 | 2006 | 2005 | 2006 |
| Paraquat | 0.5 | Before crop emergence | 1.4(1.3) | 3.4(10.6) | 2.2(4.0) | 3.7(13.3) | 1.0(0.0) | 2.0(4.0) | 1.4(1.3) | 2.0(4.0) | 1.0(0.0) | 1.8(2.6) | 1.0(0.0) | 1.0(0.0) |
| Mulching | 5 cm | Immediately after planting | 1.0(0.0) | 1.0(0.0) | 1.0(0.0) | 1.0(0.0) | 2.9(8.0) | 1.4(1.3) | 3.7(13.3) | 2.7(8.0) | 1.0(0.0) | 1.0(0.0) | 3.4(10.6) | 1.4(1.3) |
| Metribuzin fb earthing up | 0.5 | Pre emergence | 1.0(0.0) | 1.0(0.0) | 1.0(0.0) | 1.0(0.0) | 2.2(5.3) | 1.6(2.6) | 1.0(0.0) | 2.4(5.3) | 1.0(0.0) | 1.0(0.0) | 1.0(0.0) | 1.0(0.0) |
| Pendi. fb earthing up | 1.0 | Pre emergence | 1.0(0.0) | 1.0(0.0) | 1.0(0.0) | 1.4(1.3) | 1.4(1.3) | 1.8(4.0) | 1.6(2.6) | 1.4(1.3) | 1.0(0.0) | 1.0(0.0) | 1.0(0.0) | 1.4(1.3) |
| Prometryn fb earthing up | 1.0 | Pre emergence | 1.0(0.0) | 1.0(0.0) | 1.0(0.0) | 1.0(0.0) | 1.4(1.3) | 1.6(2.6) | 1.0(0.0) | 1.0(0.0) | 1.0(0.0) | 1.0(0.0) | 1.0(0.0) | 2.2(5.3) |
| Earthing up | Once | 60 DAP | 1.4(1.3) | 1.0(0.0) | 1.4(1.3) | 1.8(4.0) | 1.0(0.0) | 1.0(0.0) | 1.4(1.3) | 2.5(6.6) | 1.0(0.0) | 1.0(0.0) | 1.0(0.0) | 1.6(2.6) |
| Hand weeding | Twice | 60 & 90 DAP | 1.0(0.0) | 1.8(4.0) | 1.0(0.0) | 1.0(0.0) | 1.0(0.0) | 1.4(1.3) | 1.0(0.0) | 1.0(0.0) | 1.0(0.0) | 1.0(0.0) | 1.0(0.0) | 1.0(0.0) |
| Unweeded | - | - | 4.0(16.0) | 1.6(2.6) | 4.5(21.3) | 4.8(22.6) | 2.4(5.3) | 2.7(6.6) | 3.2(9.3) | 3.4(10.6) | 2.0(4.0) | 1.4(1.3) | 5.6(36.0) | 3.9(14.6) |
| LSD (P=0.05) | - | - | 0.8 | 1.2 | 1.1 | 1.2 | 1.2 | NS | 1.0 | NS | 0.6 | NS | 1.9 | 1.4 |

Data transformed to root transformation; Values in the parentheses are the means of original values.

**Table 3. Effect of treatments on total weed population, total weed dry accumulation and potato tuber yield**

| Treatment | Rate (kg ha$^{-1}$) | Time of application | Total weed population m$^{-2}$ | | Total dry matter accumulation(g m$^{-2}$) | | Tuber yield (q ha$^{-1}$) | |
|---|---|---|---|---|---|---|---|---|
| | | | 2005 | 2006 | 2005 | 2006 | 2005 | 2006 |
| Paraquat | 0.5 | Before crop emergence | 3.4(10.7) | 5.8(34.6) | 2.4(5.4) | 1.4(1.0) | 188.9 | 190.4 |
| Mulching | 5 cm | Immediately after planting | 6.8(46.7) | 6.2(38.6) | 5.1(26.1) | 1.6(1.7) | 108.3 | 170.2 |
| Metribuzin fb earthing up | 0.5 | Pre emergence | 3.9(15.2) | 3.8(14.6) | 2.2(4.5) | 1.3(0.8) | 198.1 | 220.9 |
| Pendi. fb earthing up | 1.0 | Pre emergence | 3.1(8.8) | 4.6(21.3) | 3.1(8.8) | 1.4(1.2) | 195.0 | 204.5 |
| Prometryn fb earthing up | 1.0 | Pre emergence | 2.0(3.4) | 4.5(20.0) | 2.0(3.4) | 1.4(1.1) | 212.2 | 211.6 |
| Earthing up | Once | 60 DAP | 3.0(8.7) | 4.6(21.3) | 3.0(8.7) | 1.3(2.8) | 155.6 | 163.9 |
| Hand weeding | Twice | 60 & 90 DAP | 1.3(0.9) | 1.0(0.0) | 1.3(0.9) | 1.0(0.0) | 179.8 | 194.0 |
| Unweeded | - | - | 8.0(64.2) | 12.9(168.0) | 8.0(64.2) | 5.7(32.1) | 86.1 | 95.2 |
| LSD (P=0.05) | - | - | 1.4 | 1.6 | 1.2 | 0.4 | 34.8 | 45.5 |

Data transformed to $\sqrt{x+1}$ root transformation; Values in the parentheses are the means of original values.

**Table 4. Monetary returns as influenced by crop- weed competition (mean of 2005 and 2006)**

| Treatment | Dose (kg ha$^{-1}$) | Time of application | Gross returns (Rs./ha) | Variable cost (Rs / ha) | Net returns (Rs /ha) | B : C ratio |
|---|---|---|---|---|---|---|
| Paraquat | 0.5 | Before crop emergence | 49500 | 1493 | 48007 | 32.15 |
| Mulching | 5 cm | Immediately after planting | 24300 | 7700 | 16600 | 2.2 |
| Metribuzin fb earthing up | 0.5 | Pre emergence | 59400 | 4960 | 54440 | 10.96 |
| Pendi. fb earthing up | 1.0 | Pre emergence | 54550 | 5468 | 49082 | 8.97 |
| Prometryn fb earthing up | 1.0 | Pre emergence | 60600 | 4920 | 55680 | 11.31 |
| Earthing up | Once | 60 DAP | 34550 | 3300 | 31250 | 9.46 |
| Hand weeding | Twice | 60 & 90 DAP | 48100 | 8800 | 39300 | 4.46 |
| Unweeded | - | - | | | | |

Metribuzine-Rs 1400/kg, Paraquat- Rs 400/L, Pendimethalin- Rs 460/L, Prometryn-Rs 480/kg

weeding twice significantly increased potato tuber yield over other treatment. Similar results with of metribuzin 0.75 kg ha$^{-1}$ and prometryn 1.0 kg ha$^{-1}$ have also been reported by other workers (Singh *et al.*, 2007; Kumar *et al.*, 2007 and Tomar *et al.*, 2008). Metribuzin fb. earthing up, prometryn fb. earthing up, pendimethalin fb. earthing up, paraquat and hand weeding twice increased potato tuber yield by 31.1, 32.6, 25.0, 18.7 and 17.0%, respectively over the farmers practices of earthing up. The respective increase in yield due to these treatments over weedy check was 131.0, 133.6, 120.3, 109.2 and 106.1%.

## Economics

Additional gross returns over weedy check were highest under prometryn fb. earthing up, followed by metribuzin fb. earthing up, pendimethalin fb. earthing up, paraquat, hand weeding twice, earthing up and

mulching (Table 4). Net returns over weedy check were highest under prometryn fb. earthing up followed by metribuzin fb. earthing up, pendimethalin fb. earthing up, paraquat hand weeding twice earthing up and mulching in that order. However, paraquat gave highest net profit/rupee invested (32.2) as compared to prometryn fb. earthing up (11.3), metribuzin fb earthing up (11.0), earthing up (9.3) and pendimethalin fb. earthing up (9.0). It was mainly due to low herbicide cost which ultimately resulted in lower application cost. Superiority of herbicides over age old traditional manual weeding with respect to B: C ratio has also been reported by Singh *et al* (2007).

It can be unfenced that integrated weed management was the better option in terms of net returns as prometryn fb. earthing up, metribuzin fb earthing up, pendimethalin fb. earthing up surpassed paraquat, mulching, earthing up and hand weeding. However, paraquat alone gave the highest net returns per rupee expenditure over all the other treatments. It showed that the resource poor farmers should at least apply paraquat alone in the mid hill conditions of Himachal Pradesh for sustained economic productivity of potato.

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