Effect of different herbicides levels on yield and economics of returns in potato (Solanum tuberosum L.)

Ravikumar Hoogar, R Jayaramaiah, G Pramod and ST Bhairappanavar

Abstract

A field experiment was conducted during kharif 2016 at College of Agriculture, Hassan, University of Agricultural Sciences, Bengaluru to evaluate different pre and post emergent herbicides on growth and yield of potato (Solanum tuberosum L.) the soil of experimental site is red sandy loam in texture, neutral in reaction and medium in available nitrogen, phosphorus and potassium. The experiment was laid out in a RCBD with seven treatments replicated thrice. Application of Fenoxaprop–p-ethyl 54 gm a.i. ha⁻¹ as early post emergent at 20 DAP recorded significantly higher number of tubers plant⁻¹ (4.30), tuber weight plant⁻¹ (250.50 g) and tuber yield (19.77 t ha⁻¹) which was on par with Quizzalofop–p-ethyl (4.07, 247.37 g and 18.93 t ha⁻¹, respectively) except weed free check. Among herbicide treatments, higher gross returns, net returns and BC ratio were realized in treatment T₃ i.e., Fenoxaprop–p-ethyl 54 g a.i. ha⁻¹ as early post emergent (₹ 1,97,667 ha⁻¹, 1,39,622 ha⁻¹ and 3.41). Whereas lower gross returns, net returns and BC ratio were realized in weedy check (₹ 1,40,000 ha⁻¹, 83, 408 ha⁻¹ and 2.47).

Keywords: potato, weed, fenoxaprop–p-ethyl, tuber yield and economics of returns

Introduction

Potato (Solanum tuberosum L.) is one of the most important vegetable cum food crops of the world. It belongs to family Solanaceae and genus Solanum, and native of the Andean plateau of South America. It has the capacity to produce more energy and protein per unit area per unit time. Potato protein is superior to that of cereals and rich in essential amino acid lysine and vitamin C. Hence, potato is one of the richest sources of calories needed to maintain day to day output of human energy. Potato is cultivated in 2.13 m ha⁻¹ in India, with a production of 43.7 m t and productivity of 20.5 MT ha⁻¹ (Anon., 2016) [2]. At present, potato is grown in about 15 countries of the world on a wide range of soils and agro climatic conditions (Khuranka and Naik, 2003) [8].

Hand weeding and hoeing are common practices followed in India. However, timely weed control may not be possible manually due to non availability of labours 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. Presence of weeds throughout the growing period of the crop caused 62 per cent reduction in tuber yield. However, the weeds prevalent in and around the crop hamper potato cultivation thereby resulting in substantial reduction in yield (Singh et al., 1984) [11]. Manual weeding is quite effective but costly, tedious, time consuming and also causes root injury (Khurana et al. 1993) [9].

Use of suitable herbicides alone or in combination with manual or mechanical weeding for weed control reduce the cost towards weed control by 75-85 per cent compared to manual weeding (Gopinath and Mina, 2009) [6]. In Hassan district of Karnataka, scarcity of labourers is found during crop season and the labour charges are also very high which increases the cost of production. In this situation, farmers of Hassan district need suitable technology for weed management. Hence, the present study is undertaken to find out an effective and economical weed control method for increasing productivity of potato.

Advantages of chemical weed control lie in its superior efficiency, economy and easiness. Chemicals like pendimethalin and alachlor as pre-emergence and paraquat as early post emergence have been used for weed control in potato. But weeds generally emerge during later stage of crop growth even after application of aforesaid weedicides.
Material and Methods
A field experiment was conducted during kharif 2016 at College of Agriculture, Hassan, University of Agricultural Sciences, Bengaluru. The experimental site is geographically situated in the Southern Transitional Zone (Zone-7) of Karnataka and located between 12° 13' and 13° 33' N Latitude and 75° 33' and 76° 38' E Longitude at an altitude of 827 m above Mean Sea Level (MSL). The soil of the experimental site was red sandy loam. The experiment was laid out in randomized block design with seven treatments and replicated thrice.

Variatel description of Kufri Jyothi
Tubers are large oval flattened with white skin eyes fleet and flesh is dull white in colour. A widely adaptable fertilizer responsive variety possessing high degree of field resistance to late blight disease in the foliage and also a good degree of tuber resistance to the same disease. This is also resistant to the wart and moderately resistant to cercospora leaf spot. It is being recommended in various states in India including Karnataka for commercial cultivation.

It matures in 110-120 days in the hills and it takes 100 days to mature in plains. It yields 180-200 q ha⁻¹ in the hills. In plains including Karnataka Kufri Jyothi yields 150-200 q ha⁻¹ under irrigated conditions and 75-100 q ha⁻¹ under rainfed conditions.

Imposition of treatments
The required quantities of herbicides were applied as pre emergence (2 days after planting) and early post emergence (20 DAP) as per the treatments. The conventional weed control practices followed by the farmers and check treatments Viz., weedy check and weed free check. Pre-emergent application of Metribuzin 500 g a.i. ha⁻¹ was imposed on 17/06/2016. Early post emergent application of Fenoxaprop--p-ethyl 54 g a.i. ha⁻¹, Quizalofop--p-ethyl 30 g a.i. ha⁻¹, Paraquat dichloride 480 g a.i. ha⁻¹ was imposed on 05/07/2016.

Pre emergence application of herbicide
The crop was planted on June 15th, 2016 and the pre emergence herbicide Metribuzin was sprayed uniformly on 17th June 2016 with high volume sprayer (750 litresha⁻¹).

Early post emergent application of herbicides
The early post emergent herbicides Fenoxaprop--p-ethyl, Quizalofop--p-ethyl, Paraquat dichloride were sprayed uniformly 20 days after planting with high volume sprayer.

Economics of returns
The cost of cultivation was computed by considering prices of inputs prevailed during their use for different treatments. Similarly, the ruling market price for potato and herbicides was considered for calculating gross return. The cost of cultivation was deducted from gross returns to arrive at net profit per hectare. Benefit cost ratio was worked out as follows.

\[
\text{Benefit cost ratio} = \frac{\text{Gross return (\text{\textcurrency per ha})}}{\text{Total cost of cultivation (\textcurrency per ha)}}
\]

Statistical analysis and interpretation of data
The data was statistically analyzed by following the method of Gomez and Gomez (1984) [5]. The observations on weed growth like weed density and weed dry weight were recorded at 30, 60 DAP and at harvest. Data on weed count and weed dry weight showed high variation. To make the analysis of variance more valid the data on weed count and weed dry weight was subjected to square root transformation by using formula √x + 0.5 (Chandel, 1984) [6]. Critical difference for the significant source of variation was calculated at five per cent level of significance. Treatment differences those were not significant were denoted by NS.

Result and discussion
Effect of different pre and post emergent herbicides on yield and yield attributes and tuber grading of potato at harvest
Application of Fenoxaprop--p-ethyl 54 g a.i. ha⁻¹ as early post emergent recorded significantly higher tuber weight (250.50 g), number of tubers (4.30) and tuber yield (19.77 t ha⁻¹). Higher tuber yield was attributed to better control of weeds, lower weed index (5.9 %) and higher weed control efficiency (73.3 %) throughout the crop growth period, which resulted in better availability of growth factors like light, space, nutrients and moisture to the potato crop resulting in better crop growth and yield. These findings are in confirmatory with the work of Chitsaz and Nelson (1983) [4]Table 1. The higher yield of ‘B’ grade (25-100g) and ‘C’ grade (>100g) tubers were recorded with early post emergent application of Fenoxaprop--p-ethyl 54 g a.i. ha⁻¹ which was found on par with the application of Quizalofop--p-ethyl 30 g a.i. ha⁻¹ as early post emergent, except weed free check. Higher yield of ‘B’ grade and ‘C’ grade tuber was due to efficient control of annual weeds during early stage of the growth by applied herbicides. The lower ‘A’ grade tubers (<25 g) were recorded with early post emergent application of Fenoxaprop--p-ethyl 54 g a.i. ha⁻¹ due to effective control of weeds at initial stage of the crop period as well as reduced weed dry weight and also due to higher weed control efficiency.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Tuber weight plant⁻¹(g)</th>
<th>Number of tubers plant⁻¹</th>
<th>Tuber grading (t ha⁻¹)</th>
<th>Tuber yield (t ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁</td>
<td>Farmers practice</td>
<td>235.67</td>
<td>2.50</td>
<td>4.20</td>
</tr>
<tr>
<td>T₂</td>
<td>Metribuzin 500 g a.i. ha⁻¹ as PE</td>
<td>242.67</td>
<td>3.43</td>
<td>3.30</td>
</tr>
<tr>
<td>T₃</td>
<td>Fenoxaprop--p-ethyl 54 g a.i. ha⁻¹ as EPE</td>
<td>250.50</td>
<td>4.30</td>
<td>3.00</td>
</tr>
<tr>
<td>T₄</td>
<td>Quizalofop--p-ethyl 30 g a.i. ha⁻¹ as EPE</td>
<td>247.67</td>
<td>4.07</td>
<td>3.15</td>
</tr>
<tr>
<td>T₅</td>
<td>Paraquat dichloride 480 g a.i. ha⁻¹ as EPE</td>
<td>238.67</td>
<td>3.00</td>
<td>3.90</td>
</tr>
<tr>
<td>T₆</td>
<td>Weedy check</td>
<td>221.67</td>
<td>2.10</td>
<td>4.40</td>
</tr>
<tr>
<td>T₇</td>
<td>Weed free check</td>
<td>253.33</td>
<td>4.50</td>
<td>2.67</td>
</tr>
<tr>
<td>S.Em+</td>
<td></td>
<td>3.57</td>
<td>0.14</td>
<td>0.16</td>
</tr>
<tr>
<td>LSD(α=0.05)</td>
<td></td>
<td>10.99</td>
<td>0.44</td>
<td>0.51</td>
</tr>
</tbody>
</table>

Note: PE: pre-emergent application EPE: early post emergent application
Effect of different pre and post emergent herbicides on economics of returns

Among different weed management practices, higher cost of cultivation was recorded in treatment T1 i.e., Weed free check (₹. 62,593 ha\(^{-1}\)), among herbicide treatments, lower cost of cultivation were recorded in treatment T3 i.e., Fenoxaprop–p-ethyl 54 g a.i. ha\(^{-1}\) as early post emergent (₹.58,045 ha\(^{-1}\)) followed by in T4 i.e., Quizalofop–p-ethyl 30 g a.i. ha\(^{-1}\) as early post emergent (₹. 58,073 ha\(^{-1}\)). Significantly higher gross returns and net returns were realized in treatment T3 i.e., Weed free check (₹. 2,10,000 ha\(^{-1}\) and 1,47,408 ha\(^{-1}\)). Among herbicide treatments, higher gross returns and net returns were realized in treatment T3 i.e., Fenoxaprop–p-ethyl 54 g a.i. ha\(^{-1}\) as early post emergent (₹. 1,97,667 ha\(^{-1}\) and 1,39,622 ha\(^{-1}\)). Whereas higher benefit cost ratio in potato was obtained in treatment T3 i.e., Fenoxaprop–p-ethyl 54 g a.i. ha\(^{-1}\) as early post emergent (3.41), followed by T4 i.e., Quizalofop–p-ethyl 30 g a.i. ha\(^{-1}\) as early post emergent (3.26). Whereas, significantly lower benefit cost ratio was obtained in weedy check (2.47). Diffusion and successful adoption of any technology depends on the economic superiority of that technology over the existing technology in terms of higher net returns and B:C ratio realized. In the present investigation all weed management practices achieved higher net returns and B:C ratio over weedy check. This might be due to higher tuber yield, better control of weeds throughout crop growth period along with lower cost of weed control with the use of Fenoxaprop–p-ethyl 54 g a.i. ha\(^{-1}\) as early post emergent. The results obtained are in accordance with Sarkar (2006) [10]; Mahbubul (2014) [9], (Table 2). However, the lower net returns were obtained in weedy check due to low tuber yield as a result of more crop weed competition. These results are in line with the findings of Chitsaz and Nelson (1983) [4]; Sarkar (2006) [10]. Although higher tuber yield was realized in T3 i.e., Weed free check due to higher cost of cultivation in terms of higher requirement of labours for weeding the net returns realized were on a lower side when compared to the treatment T3 i.e., Fenoxaprop–p-ethyl 54 g a.i. ha\(^{-1}\) as early post emergent.

### Table 2: Effect of different pre and post emergent herbicides on economics in potato.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Cost of cultivation (₹. ha(^{-1}))</th>
<th>Gross returns ( ₹. ha(^{-1}))</th>
<th>Net returns ( ₹. ha(^{-1}))</th>
<th>B:C ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Farmers practice</td>
<td>57593</td>
<td>161667</td>
<td>104074</td>
</tr>
<tr>
<td>T2</td>
<td>Metribuzin 500 g a.i. ha(^{-1}) as PE</td>
<td>58713</td>
<td>181000</td>
<td>122288</td>
</tr>
<tr>
<td>T3</td>
<td>Fenoxaprop–p-ethyl 54 g a.i. ha(^{-1}) as PE</td>
<td>58045</td>
<td>197667</td>
<td>139622</td>
</tr>
<tr>
<td>T4</td>
<td>Quizalofop–p-ethyl 30 g a.i. ha(^{-1}) as EPE</td>
<td>58073</td>
<td>189333</td>
<td>131261</td>
</tr>
<tr>
<td>T5</td>
<td>Paraquat dichloride 480 g a.i. ha(^{-1}) as EPE</td>
<td>57743</td>
<td>174333</td>
<td>116591</td>
</tr>
<tr>
<td>T6</td>
<td>Weedy check</td>
<td>56593</td>
<td>140000</td>
<td>83408</td>
</tr>
<tr>
<td>T7</td>
<td>Weed free check</td>
<td>62593</td>
<td>210000</td>
<td>147408</td>
</tr>
</tbody>
</table>

Note: PE: pre-emergent application EPE: early post emergent application

### Conclusion

The study concluded that application of early post emergent herbicide like fenoxaprop–p-ethyl 54 g a.i. ha\(^{-1}\) resulted in higher number of tubers (4.30) and tuber yield (19.77 t ha\(^{-1}\)) and profitable potato cultivation (net returns of ₹.1,39,622 and B:C ratio of 3.41) under present labour constraint conditions in potato crop except weed free check.

### References