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Efficiency of Three Weeds Control Methods Alone and in Combination with Farm Yard Manure in Potato

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Abstract: The efficiency of pre-emergence herbicide, post-emergence herbicide and hand weeding alone as well as in combination with farm yard manure (FYM) were studied in potato for three years. The emergence percentage was at the top (84.6) where pre-emergence herbicide was sprayed and FYM was not added followed by (84.3) hand weeding in which FYM was used. The uncontrolled weed plots gave an average of 535.8 g m⁻² more fresh weeds weight than weeds controlled plots. The hand weeding plots gave an average of 58.9 g m⁻² more fresh weeds weight than chemically weed controlled plots. The pre-emergence herbicide controlled plots yielded an average of 111.1 g m⁻² more fresh weeds weight as compared to post-emergence herbicide controlled plots. The percentage of > 55 mm tubers was at the top (55.1) where post-emergence herbicide was sprayed and FYM was added followed by (50.2%) pre-emergence herbicide treated plots in which FYM was not added. The seed size (35-55 mm) tuber percentage was at the top (41.1) where weeds were not eradicated and FYM was not added followed by (40.8%) hand weeding plots in which FYM was added. The percentage of <35 mm tubers was at the bottom (11.2) where pre-emergence herbicide was sprayed and FYM was added. Weeds control by any methods increased potato yield an average of 7.983 t ha⁻¹ (27.52%) than the uncontrolled weeds plots. The FYM increased an average of 3.687 t ha⁻¹ (10.49%) yield in potato as compared to plots in which FYM was not applied. The chemically weed controlled methods produced an average of 4.482 t ha⁻¹ (13.18%) more potatoes than hand weeding. The post-emergence herbicide, on an average basis yielded more potatoes than pre-emergence herbicide. The difference was 3.355 t ha⁻¹ (9.11%) in the favour of post-emergence herbicide. On the basis of three years results post-emergence herbicide is recommended for effective weeds control and higher production.

Key words: *Solanum tuberosum*, pre-emergence herbicide, post-emergence herbicide, weeds, farm yard manure

Introduction

Over the years, potatoes have become an important vegetable from both farmers and consumer in Pakistan. From around 3000 ha at the time of independence, the area under cultivation increased to 107000 ha, (Hussain, 1999). Potato is a nutritious food, which provides carbohydrate, protein, minerals, vitamin C, a number of vitamins of B group and good quality fibre. It is a short duration crop capable of producing highest amount of food per unit area and time, versatile in adaptability provides flexibility in harvesting and higher returns. Due to these elegances potato has a great potential in modern agriculture for meeting the increasing food requirements. Jaswal and Lal (1996) found that weeds reduced 42% yield in potato whereas according to Malik (1995) weeds reduced 10 to 80% yields in potato. Jaswal (1994) found different response of different weedicides in potato. Banaras (1993) reported 43% yield losses due to weeds. Abid (1988) concluded that potato is a sensitive to weed

infestation particularly at early stages of its growth. All of the previous work on chemical weed control in Pakistan was carried out on pre-emergence herbicides. Among these Hanan *et al.* (1987) and Rizvi (1987) said that chemical effectively controlled weeds than hand weeding. Thakral *et al.* (1985) observed that the most critical period of crop weed competition is first 4-6 weeks after planting where crop must be kept free of weeds. Gupta *et al.* (1977) suggested that it is the allelopathic effect of weeds, which adversely effect growth and development of potato. The potato needs at least 3% organic matter most of the farmer use FYM for this purpose. The FYM increases the weeds infestation. The present studies were carried out to know the proper chemical for weed control both with and without application of FYM.

Materials and Methods

The experiment was conducted at Potato Research Station, Sialkot, with randomized complete block design

during autumn 1998-99 to 2000-2001. A new local hybrid SH-5 (Bartina x Cardinal) was planted keeping intra and inter row distance 20 and 70 cm respectively. The plot size was 6 x 2.8 m² in all three years. The fertilizer was applied @ 250-125-125 NPK kg ha⁻¹. The crop was sprayed equally according to the need with fungicide and insecticide during the growing season of three years to protect from insect's pests and fungal diseases. The well rotten farm yard manure (FYM) was added in three treatments @ 7.5 t ha⁻¹ where as three treatments was without FYM. Three weed control methods i.e., hand weeding, pre-emergence (Stomp 30 EC) and post-emergence (Sencor 70WP) were applied in the six treatments. The seventh treatment was considered as control in which no weed control and no FYM was added. Dehauling was practised in third week of January in all three years to impede transmission of viral diseases through *Myzus persicae*. The observations recorded on different growth and yield parameters of the crop during three growing seasons were emergence percentage, fresh weeds weight per meter square at dehauling, tuber %age of >55 mm, tuber percentage 35-55 mm, tuber percentage < 35 mm and total tuber yield per hectare.

The data was analyzed according to Steel and Torrie (1980). The treatment mean squares were partitioned in six orthogonal contrasts according to Paterson (1989).

Results and Discussion

The results (Table 1) revealed that fresh weeds weight per meter square and potato yield t ha⁻² showed significant differences in seven treatments for three weed control methods. These characters were further analyzed for orthogonal contrast. The orthogonal contrast revealed statistically significant differences for fresh weeds weight per meter square during the year 1998-99 between control in which weeds were not controlled and all other treatments in which weed were eradicated. All the other contrasts were statistically similar. In the years 1999-00 and 2000-01 all the contrasts i.e. control verses others, FYM verses no FYM adding, hand verses herbicide weed control and pre-emergence verses post-emergence herbicide were statistically differed from each others for fresh weeds per meter square. In the combine three year analysis weeds control verses non weed control, FYM verses no FYM use and pre-emergence verses post-emergence herbicide were statistically differed from each others for fresh weeds per meter square.

Potato yield t ha⁻² during the year 1998-99 and 2000-02 showed significant differences among control plot verses others in which weeds were removed, FYM verses no FYM applying, hand verses herbicide weed control and pre-emergence verses post-emergence herbicide used

plots. In the year 1999-00 for yield of potato per hectare all contrasts were statistically differed from each other except FYM verses no FYM which indicated that addition of FYM were not contributed toward yield during this year. Three years combine analysis revealed statistically significant differences for control verses others; FYM verses no FYM and hand verses herbicide weed control for potato yield in tones per hectare. The emergence percentage and three grades i.e., >55, 35-55 and >35mm tubers percentages were statistically similar.

Emergence percentage: The data revealed that during the 1998-99 the highest emergence percentage (70.3) was recorded in post-emergence herbicide applicated plots in which FYM was added followed by (68%) hand weeding with no FYM (Table 1). In 1999-2000 the plots in which pre-emergence herbicide was used and FYM was not applied gave 100% emergence that was followed by 98.3% hand weeding and same FYM treatment. In the year 2000-2001 the emergence percentage was at the top (87.2%) in the plots in which pre-emergence herbicide was sprayed and FYM was not added followed by hand weeding plots in which FYM was added. In combine analysis the emergence percentage was at the top (84.6) where pre-emergence herbicide was sprayed and FYM was not added followed by (84.3) hand weeding in which FYM was used. The emergence percentage was statistically non significant for all the three years and also in combine analysis that indicated that it did not effect the potato yield. Difference the yield was due to other treatments.

Fresh weed weight per meter square (g): During 1998-99 the highest fresh weeds weight per meter square (908.3 g) was observed in control where weeds were not eradicated and FYM not applied, where as all the other treatments were statistically similar (Table 2). The orthogonal contrast also proved that during this year only control was statistically different from all other treatments in which weeds were controlled either through hand or chemical control methods. The plots in which weeds were not controlled produced an average of 676.1 g more fresh weeds weight per meter square as compared to plots in which weeds were controlled. The weeds control FYM applied plots yielded an average of 28.9 g m⁻² more fresh weeds weight as compared to weed control plots in which FYM was not applied. The pre-emergence herbicide sprayed plots produced an average of 113.35 g m⁻² more fresh weeds weight than post-emergence sprayed plots. The hand weeding gave an average of 104.14 g m⁻² more fresh weeds weight as compared to chemically weed controlled plots.

Table 1: Mean squares of herbicide efficacy experiment from ANOVA

Source of variance	df	Emergence%	Fresh weeds wt m ⁻²	>55 mm tuber%	35-55 mm tuber%	<35 mm tuber%	Yield M. t.ha ⁻²
1998-99							
Replication	2	5.14 NS	44844.05*	3.62NS	1.18NS	0.33NS	76.29***
Treatments	6	27.89NS	208129.76***	102.09 NS	39.44NS	46.32NS	135.33***
Control vs other	1	-	1175467.46***	-	-	-	339.8***
-	1	-	3755.55NS	-	-	-	198.25***
Hand vs herbicide	1	-	25069.44NS	-	-	-	194.67***
Pre vs post-emergence herbicide	1	-	38533.33NS	-	-	-	60.75*
FYM x (hand vs herbicide)	1	-	5877.78NS	-	-	-	13.7NS
FYM x (pre vs post-emergence herbicide)	1	-	50.0NS	-	-	-	4.75NS
Error	12	18.7	10048.21	51.65	71.21	17.06	15.35
1999-2000							
Replication	2	93.0NS	987.2NS	57.6NS	65.3NS	29.9NS	3.9NS
Treatments	6	28.6NS	108291.6***	74.6NS	50.6NS	5.1NS	36.4***
Control vs other	1	-	586438.2***	-	-	-	121.3***
FYM vs No FYM	1	-	10952.0***	-	-	-	0.7NS
Hand vs herbicide	1	-	6833.78*	-	-	-	55.2***
Pre vs post-emergence herbicide	1	-	35861.33***	-	-	-	38.5***
FYM x (hand vs herbicide)	1	-	5776.0*	-	-	-	1.8NS
FYM x (pre vs post-emergence herbicide)	1	-	3888NS	-	-	-	0.8NS
Error	12	17.2	901.08	69.35	42.72	16.4	2.92
2000-2001							
Replication	2	12.04	75.0	45.7NS	22.3 NS	29.7NS	0.21
Treatments	6	7.22	110241.8***	80.2NS	63.3 NS	18.6NS	37.97***
Control vs other	1	-	599730.8***	-	-	-	80.06***
FYM vs No FYM	1	-	17094.01***	-	-	-	104.83***
Hand vs herbicide	1	-	12532.8***	-	-	-	30.63***
Pre vs post-emergence herbicide	1	-	36730.3***	-	-	-	11.82*
FYM x (hand vs herbicide)	1	-	11014.5***	-	-	-	0.17NS
FYM x (pre vs post-emergence herbicide)	1	-	4348.6***	-	-	-	0.47NS
Error	12	9.6	107.8	42.8	21.4	17.9	2.05
Over years 1998-99 to 2000-2001							
Replication	2	42.3NS	12849.8NS	55.29NS	52.11NS	28.68NS	15.12NS
Years	2	4125.5***	8602.6NS	344.19***	94.16NS	78.54*	650.49***
Treatments	6	29.18	413912.22*	161.1NS	102.3NS	37.47NS	156.93***
Control vs other	1	-	757764.3***	-	-	-	163.9***
FYM vs No FYM	1	-	9786.01***	-	-	-	61.2***
Hand vs herbicide	1	-	13865.01NS	-	-	-	80.4***
Pre vs post-emergence herbicide	1	-	36996.3***	-	-	-	33.8NS
FYM x (hand vs herbicide)	1	-	7353.06NS	-	-	-	0.86NS
FYM x (pre vs post-emergence herbicide)	1	-	2067.19NS	-	-	-	0.62NS
Y X T	12	17.13NS	6375.4NS	49.12NS	26.23NS	16.22NS	22.38NS
Error	40	24.92	4969.94	47.77	42.64	16.53	10.37

NS= non-significant. * = Significant at P ≤ 0.05 ** = Significant P ≤ 0.01

During 1999-2000, the highest fresh weeds weight per meter square (700 g) was also recorded in control where no weeds control were practiced and FYM was not added, followed by hand weeding (300 g) in which FYM was added. The lowest fresh weeds weight m⁻² (148 g) was recorded in post-emergence herbicide plots in which FYM was added and statistically similar with the post-emergence herbicide treated plots in which no FYM was applied. The unweeded controlled plots gave an average of 477.6 g more fresh weeds weight per m² as compared to weed controlled plots. The weeds controlled plots in

which FYM was applied produced an average of 49.4 g more fresh weeds weight m⁻² than the plots in which FYM was not added. The hand weeding plots gave an average of 41.4 g m⁻² more fresh weeds weight as compared to chemically weeds controlled plots. The pre-emergence herbicide applied plots yielded an average of 109.1 g more fresh weeds weight per meter square than the post-emergence sprayed herbicide plots.

In the year 2000-2001, the highest fresh weeds weight per meter square (705 g) was also recorded in treatment where no weed control were done and FYM was not applied,

Table 2: Mean values of six traits in herbicide experiment on potato

Parameters	Post-emergence	Pre-emergence	Hand weeding	Post-emergence	Pre-emergence	Hand weeding	No weed control	Cd _i
	No FYM	No FYM	No FYM	FYM	FYM	FYM	No FYM	
1998-1999								
Emergence %	69.0	66.7	68.0	70.3	64.3	69.0	61.7	NS
Fresh weeds wt.m ⁻²	150.0 b	258.3b	245.0b	148.3b	266.7b	325.0b	908.3a	178.3
>55 mm tuber%	35.7	43.0	47.3	49.3	46.3	49.0	36.0	NS
35-55 mm tuber%	46.7	43.3	37.7	36.0	41.7	38.7	40.7	NS
<35 mm tuber%	17.6	13.7	15.0	14.7	12.0	12.3	23.3	NS
Yield M. t ha ⁻²	31.55bc	28.3bc	24.8c	40.67a	34.92ab	28.97bc	20.04d	6.97
1999-2000								
Emergence%	92.7	100	93.0	93.3	93.0	98.3	92.7	NS
Fresh weeds wt.m ⁻²	160.0d	223.0c	200.0c	148.0d	293.3b	300.0b	700.0a	54.4
>55 mm tuber%	51.7	53.7	51.0	58.3	50.7	44.7	44.0	NS
35-55 mm tuber%	35.7	35.0	36.7	30.0	38.7	41.7	41.7	NS
<35 mm tuber%	12.6	11.3	12.3	11.7	10.6	13.6	14.3	NS
Yield M. t ha ⁻²	43.98a	40.91bc	38.06c	43.65ab	39.56c	38.56c	33.92d	3.1
2000-2001								
Emergence%	83.9	87.2	82.8	83.2	84.2	85.7	85.3	NS
Fresh weeds wt.m ²	161.7f	234.7d	201.7e	150.7f	299.0c	333.3b	705.0a	18.5
>55 mm tuber%	55.7	54.0	50.7	57.7	50.7	45.0	44.0	NS
35-55 mm tuber%	36.7	35.3	37.0	28.0	38.3	42.0	41.0	NS
<35 mm tuber%	7.6	10.7	12.3	14.3	11.0	13.0	15.0	NS
Yield M. t ha ⁻²	38.29cd	35.91de	34.54ef	42.86a	41.27ab	39.09bc	33.08f	2.55
Over years 1998-99-2000-2001								
Emergence%	81.9	84.6	81.7	82.3	80.5	84.3	79.9	NS
Fresh weeds wt.m ²	157.2e	242.0cd	215.6de	149.0e	286.3bc	319.4b	771.1a	67.2
>55 mm tuber%	47.7	50.2	49.7	55.1	49.2	46.2	41.3	NS
35-55 mm tuber%	39.7	37.9	37.1	31.3	39.6	40.8	41.1	NS
<35 mm tuber%	12.6	11.9	13.2	13.6	11.2	13.0	17.6	NS
Yield M. t ha ⁻²	37.94bc	35.04c	32.47d	42.39a	38.58b	35.54bc	29.01e	3.07

Means with different letters differ significantly at P<0.05, NS= non-significant

followed by hand weeding (333.3 g) in which FYM was added. The lowest fresh weed weight m⁻² (150.7) was observed in post-emergence herbicide applied plots in which FYM was added that was statistically similar with the post-emergence herbicide treated plots in which no FYM was added. The unweeded controlled plots gave an average of 474.8 g more fresh weeds weight m⁻² as compared to weed controlled plots. The weeds controlled plots in which FYM was added produced an average of 61.6 g more fresh weeds weight m⁻² than the plots in which FYM was not applied. From the hand weeding plots on an average basis obtained 56 g more fresh weeds weight m⁻² as compared to chemical weeds controlled plots. The pre-emergence herbicide applied plots gave an average of 110.6 g more fresh weeds weight per meter square than the post-emergence sprayed herbicide plots. The three years combined analysis indicated that the highest fresh weed weight per meter square (771.1 g) was resulted from the control in which no weeding was practiced and nor the FYM added. The unweeded controlled plots produced an average of 535.8 g more fresh weed weight per m² than the plots in which weeds were controlled. The fresh weeds weight was not statistically significant for FYM verses no FYM and hand verses chemical weed control. However the FYM applied plots produced an average of 46.6 g m⁻² more fresh weeds weight than plots in which the FYM was not applied. The hand weeding plots gave an average of 58.9 g m⁻² more

fresh weeds weight than chemical weed control plots. The pre-emergence herbicide control plots yielded 111.1 g m⁻² more fresh weeds weight as compared to post-emergence herbicide weed control plots. Hence the post-emergence herbicide control weeds very effectively in potato.

> 55 mm tuber percentage: In the year 1998-99 the highest percentage of large size tubers (>55 mm) were obtained (49.3%) in post-emergence herbicide applied plots in which FYM was added followed by (49%) hand weeding with no FYM (Table 2). In 1999-2000 the plots in which post-emergence herbicide was used and FYM was applied gave the highest value of large size tubers i.e. 58.3% that was followed by 53.7% of pre-emergence herbicide treated plots with no FYM. In the year 2000-2001 the percentage of more than 55 mm tubers were at the top (57.7) in the plots in which post-emergence herbicide was used and FYM was added followed by (55.7%) post-emergence herbicide applied plots in which FYM was not added. In combine analysis the large size tuber percentage was at the top (55.1) where post-emergence herbicide was sprayed and FYM was added followed by (50.2%) pre-emergence herbicide treated plots in which FYM was not added. The percentage of >55 mm (table potato) was statistically non significant for all the three years and also in combine analysis of years indicated that all treatments produce equal quantity of table potatoes.

35-55 mm tuber percentage: The data showed that in the year 1998-99 the highest percentage of seed size tubers (35-55 mm) was yielded (46.7%) by the plots in post-emergence herbicide applied plots in which FYM was not added followed by (43.3%) pre-emergence herbicide treated plot without FYM (Table 2). During the year 1999-2000 the plots the highest and at par values of seed size tubers i.e. 41.7% were obtained in hand weeding with FYM and control in which weeds were not eradicated and FYM was not added. These values were followed by 38.7% of pre-emergence herbicide treated plots with the use of FYM. In the year 2000-2001 the percentage of 35-55 mm tubers were at the top (42) in the plots in which hand weed eradication was practiced and FYM was added followed by (41%) the control plot in which weeds were not eradicated and FYM was not added. In combine analysis the seed size tuber percentage was at the top (41.1) where weeds were not eradicated and FYM was not added followed by (40.8%) hand weeding plots in which FYM was added. The percentage of 35-55 mm tuber was statistically non-significant for all the three years and also in combine analysis of years, which suggested that all treatments produce equal quantity of seed size tubers.

< 35 mm tuber percentage: During the year 1998-99 the lowest percentage of "goli" i.e. small size tubers (<35 mm) were noticed (12%) in pre-emergence herbicide treated plots and FYM was added where as the highest percentage of this grade was received (23.3%) from control in which no FYM was added nor the weeds were eradicated (Table 2). In the year 1999-2000 the plots in which pre-emergence herbicide was used and FYM was applied yielded lowest (10.6%) small size tuber. However in this year the highest percentage of <35 mm (14.3) was received from check in which no FYM was added nor the weeds were eradicated. In the year 2000-2001 the percentage of small size tubers was at the bottom (7.6%) in the plots in which post-emergence herbicide was sprayed and FYM was added where as the check was at the top (15%). In three years combine analysis the %age of <35 mm tubers was at the bottom where pre-emergence herbicide was sprayed and FYM was added after scouring 11.2%. The highest percentage of small size tubers was yielded (17.6) by the check plots in which no FYM was added nor the weeds were eradicated. The percentage of <35 mm tubers was statistically nonsignificant for all the three years under study and also in combine analysis which indicated that all the treatment including check produce equal quantity of small size tubers.

Potato yield: The results of present study revealed that during 1998-99, the treatment in which FYM was applied and plot was sprayed with post-emergence herbicide yielded highest quantity of potatoes (40.67 t ha⁻²) than all other treatments and it was followed by the treatment

having pre-emergence herbicide and FYM was added by producing 34.92 t ha⁻² (Table 2). The lowest yield was recorded (20.02 t ha⁻²) in the plots where no weed control was practiced with also nor application of FYM. The weeds control plots produced an average of 11.945 t ha⁻² (57.4%) more potatoes than the plots in which weeds were not controlled. Chemical weeds control either with pre or post-emergence gave on average basis 6.975 t ha⁻² (25.94%) more yields than hand weeding. The FYM applied plots yielded an average of 6.636 t ha⁻² (23.52%) more potatoes than the plots in which FYM was not applied. The post-emergence herbicide applied plots produced an average of 4.5 t ha⁻² (14.2%) more yields as compared to pre-emergence applied plots that may be due to effective weeds control.

In 1999-2000 the same trend was observed as in 1998-99. The highest yield 43.98 t ha⁻² was recorded in the observation in which post-emergence herbicide was sprayed and FYM was added which was followed by (43.65 t ha⁻²) the statistically similar value of observational plots in which pre-emergence herbicide was used and FYM was applied. The lowest yield of 33.92 t ha⁻² come from plots in which weeds were not controlled and FYM was not added. The weeds control plots gave an average of 6.37 t ha⁻² (18.78%) more produce than the plots in which weeds was not controlled. Chemical weeds control either with pre or post-emergence yielded on an average basis 3.715 t ha⁻² (9.7%) more tubers than hand weeding. The FYM applied plots yielded an average of statistically similar quantity of potatoes in which FYM was not applied. The post-emergence herbicide applied plots produced an average of 3.58 t ha⁻² (8.9%) more yields than the pre-emergence applied plots.

In the year 2000-2001 the highest yield (42.86 t ha⁻²) was obtained in the plot in which post-emergence herbicide was applied and FYM was added followed by (41.27 t ha⁻²) statistically similar value of plots in which pre-emergence herbicide was sprayed and FYM was used. The lowest potatoes were yielded (33.08 t ha⁻²) by the check plots in which weeds were not controlled and nor FYM was added and it was statistically similar (34.54 t ha⁻²) with the plot in hand weeding was practiced and no FYM was added. The weeds controlled plots gave an average of 5.58 t ha⁻² (16.87%) more yields than the plot in which weeds were not eradicated. The chemical weed controlled plots produced an average of 2.767 t ha⁻² (7.51%) more yield than manual weeding by hand. The FYM applied plots produced an average of 4.826 t ha⁻² more tubers as compared to plots in which FYM were not added. The application of herbicide after emergence yielded an average of 1.985 t ha⁻² (5.14%) more potatoes than the plots in which herbicides were applied before emergence.

Three years average data divulged that the average of the plots were at the top (42.39 t ha^{-2}) in which post-emergence herbicide was used and FYM was added followed by statistically different average value (38.58 t ha^{-2}) of plots in which pre-emergence herbicide was sprayed and FYM was used (Table 2). The lowest potato yield (29.01 t ha^{-2}) was obtained in which FYM was not applied and weeding was not practiced. The Table 2 also indicated that control of weeds increased on an average of 7.983 t ha^{-2} (27.52%) yield in potato as compared to non control of weeds. Studies conducted by Gupta *et al.* (1977), Banaras (1993), Malik (1995) and Jaswal and Lal (1996) supported these finding that decrease the over all potato yield. The FYM increased an average of 3.687 t ha^{-2} (10.49%) tuber yield as compared to no FYM application. Hence the farmers are advice to use well rotten FYM which will increase their yield. The chemical weed control methods produced an average of 4.482 t ha^{-2} (13.18%) more potatoes than hand weeding these results are in accordance with Hanan *et al.* (1987) and Rizvi (1987) findings they said that chemical effectively controlled weeds than hand weeding. Although the pooled analysis of three years suggested no statistical significant differences among pre and post-emergence herbicide but there was statistically significant difference during 1998-99 and 2000-01. The post-emergence herbicide produced an average of 3.355 t ha^{-2} (9.11%) more potato yield than pre-emergence herbicide. This may be due to effective weed control with the post-emergence herbicide. The similar results were in the study of Jaswal (1994) who found different response of different weedicides in potato. Hence the farmer are recommended to use post-emergence herbicide for effective control of weeds in potato.

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