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Effect of Herbicide on Weed Management in Potato

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Abstract

A field experiment was conducted under All India Co-ordinated Research Project on Potato at Horticulture Research and Extension Centre (HREC), Hassan, Karnataka consecutively for three years during *Kharif* season of 2014, 2015 and 2017 to study the effect of herbicide on weed management in potato cv. Kufri Jyoti. Weed management is a major component in potato production and has been accomplished using different methods. In the experiment both manual and chemical methods were adopted to control weeds in potato. An experiment was laid out in Randomized Complete Block Design with four replications by following standard spacing of 60×20 cm^2. In this study, treatments with hand weeding at 30, 40 and 50 days interval and metribuzine as both pre-emergent and post emergent herbicide were sprayed. Among the seven different treatments, pre-emergent spray of metribuzin @ 0.75 kg ha^{-1} (1 g l^{-1}) at planting of tubers recorded highest marketable tuber yield of 12.32 t ha^{-1} and total tuber yield of 14.29 t ha^{-1} with benefit cost ratio of 1.55 followed by the treatment with post-emergent spray of metribuzin @ 0.75 kg ha^{-1}, which was documented marketable tuber yield of 11.79 t ha^{-1} and total tuber yield of 13.71 t ha^{-1} with benefit cost ratio of 1.48. Hence, metribuzin @ 0.75 kg ha^{-1} (1 g l^{-1}) can be used as an effective herbicide for the management of weeds in potato cultivation under Southern Dry Zone of Karnataka.

Keywords: B:C ratio, *kharif*, Kufri Jyoti, potato, weed management, yield.

1. Introduction

Potato is also called as poor man's strength or king of vegetables. It is a staple food prevailing all across the world with successful large-scale production, consumption and availability. It is one of the most diverse and nutritious crops on the universe and can be grown almost all the continents. Potato is one of the most important commercial vegetable crops widely grown in India. Growth and development of potato and its tuber yield depends on bio-genetic potential of a variety and cultural practices to which crop is subjected. There are several constraints in potato production, of which weeds often pose a serious problem. Even though potato plants have robust growing and quick spreading nature, but it turns as a weak competitor with weeds. Weeds not only compete with crop plants for nutrients, soil moisture, space and sunlight, but also serve as an alternate host for several insect pest and diseases. Wider spacing, frequent irrigations and liberal application of manures and fertilizers provide favorable conditions for an early start of weeds well before the emergence of potato plant. Singh and Bhan (1999) reported that the presence of weeds throughout the growing season caused 62% reduction in tuber yield. It was observed that the most critical period of crop-weed competition is first 4 to 6 weeks after planting. Hence, the yield reduction due to weeds in potato is estimated to be as high as 10 to 80% (Lal and Gupta, 1984). So, control of weeds in the initial stages appears imperative as it plays an important role in maximizing the tuber production.

Yield losses in potato due to weeds occur in several ways. Among these, competition between potato plants and weeds for nutrients is the major contributing factor. The nutrient losses caused by weeds in the potato crop at Shimla amounted to 43, 8 and 49 kg N, P and K $hectare^{-1}$, respectively (Nankar and Singh, 1982). Chemical weed control is one of the most significant component of integrated weed management for this crop and molecules like metribuzin, isoproturan etc. are available commercially for this purpose (Kumar et al., 2009). Bellinder et al. (2000) combined cultivation with banded applications of herbicides to control in- and between-row weeds while reducing herbicide use. Bhullar et al. (2015) found that a combination of straw mulch and atrazine can provide effective weed control in potato. Hence, chemical weed control in integrated weed management practices appears to hold a great promise in dealing with effective, timely and economic weed control. However, farmers in this region usually grow potato without having proper knowledge on use

of herbicide. Therefore, keeping all these points present study was conducted to find out suitable and economically viable weed management practice during *kharif* season for potato cultivation in Southern Dry Zone of Karnataka.

2. Materials and Methods

The present investigation was conducted during *kharif* season 2014, 2015 and 2017 to study the effect of herbicide on weed management in potato cv Kufri Jyoti under AICRP-Potato at Horticultural Research and Extension Center, Hassan, Karnataka. The soil of the experimental area was red sandy loam having good physical, chemical properties and pH of the soil was 6.2. The design followed was Randomized Complete Block Design with seven treatments in four replications having a plot size of 3.6 m × 3.0 m and tubers planted with the spacing of 60 cm × 20 cm.

The treatments included under the study were as follows
T_1: Weed check
T_2: Weed free
T_3: Hand weeding at 30 days after planting
T_4: Hand weeding at 40 days after planting
T_5: Hand weeding at 50 days after planting
T_6: Metribuzin @ 0.75 kg ha^1 (Pre-emergence)
T_7: Metribuzin @ 0.75 kg ha^{-1} (Post-emergence)
The observations related to vegetative growth and yield attributes were recorded as follows:

2.1. Plant emergence (%) at 30 days after planting

Plant emergence (%)=(Total number of tubers germinated/ Total number of tubers planted)×100

2.2. Weed count meter square

The number of weeds meter^{-2} was counted manually in each treatment for all replications and computed mean data.

2.3. Yield attributes

2.3.1. Marketable and Un-marketable tuber yield (t ha^{-1})

Of total tubers obtained in each plot, all tubers were sorted into two different grades based on their weight as marketable tuber yield (>25 g) and un-marketable tuber yield (<25g) and further transformed into tonnes hectare^{-1}.

2.3.2. Total tuber yield (t ha^{-1})

Addition of both marketable tuber yield (>25g), un marketable tuber yield (<25g) is the total tuber yield and transformed into tonnes hectare^{-1}.

2.3.3. Cost economics (INR ha^{-1})

The cost economics and benefit cost ratio were worked out at the end of the crop based on the cost of cultivation and net income obtained after marketing of tubers.

3. Results and Discussion

The observations on plant emergence (%), weed count (m^{-2}), marketable tuber yield, unmarketable tuber yield, total tuber yield and benefit cost ratio were documented for three years 2014, 2015 and 2017.

3.1. Growth parameters

The pooled data analysis for growth parameters indicated that among all the treatments, highest plant emergence of 86.56% was reported in T_1: weed check followed by T_7: Metribuzin @ 0.75 kg ha^{-1} (Post-emergence) (83.64 %) which was on par with T_6: Metribuzin @ 0.75 kg ha^{-1} (Pre-emergence) (83.24%) (Table 1). Weeds were highly vigorous at the initial stage of crop and continuously emerged throughout the crop season resulting in higher state of crop-weed competition even before emergence of crop especially in control plots. Mukherjee et al. (2012) in their study on weed management practices observed that, metribuzin @ 0.50 kg ha^{-1} at 7 DAP recorded highest weed control efficiency both at research farm and at farmers field during harvest. Which was closely followed by mulching, metribuzin @ 0.30 kg ha^{-1} and pendimethalin @ 0.60 kg ha^{-1}.

3.2. Yield parameters

The pooled data over three years revealed that, T_6: Pre-emergence spray of metribuzin @ 0.75 kg ha^{-1} recorded highest marketable tuber yield of 12.32 t ha^{-1} followed by T_7:

Table 1: Effect of herbicide on weed management on growth and yield parameters of potato

Treatment details	Plant emergence (%)				No. of weeds m^{-2}			
	2014	2015	2017	Pooled	2014	2015	2017	Pooled
T_1- Weed check	85.75	89.42	84.50	86.56	20.32	18.37	19.00	46.23
T_2- Weed free	79.85	88.10	74.50	80.82	6.46	8.35	8.00	7.60
T_3- Hand weeding at 30 days	82.50	87.83	73.89	81.41	17.93	18	17.12	28.00
T_4- Hand weeding at 40 days	73.59	82.54	61.94	72.69	17	16.98	16.08	24.00
T_5- Hand weeding at 50 days	80.14	84.65	74.78	79.86	18.28	18.75	17.79	35.50
T_6- Metribuzin @ 0.75 kg ha^{-1} (Pre-emergence)	85.52	88.10	76.95	83.52	12.25	13.25	11.93	7.48
T_7- Metribuzin @ 0.75 kg ha^{-1} (Post-emergence)	84.82	88.15	77.94	83.64	10.79	11.00	9.76	8.30
SEm±	2.14	3.10	1.98	1.49	0.23	1.47	1.68	4.89
CD (*p*=0.05)	6.59	9.56	6.11	4.60	0.69	4.41	5.04	14.67
CV (%)	4.53	6.18	4.59	3.18	7.38	9.34	11.37	18.60

Post-emergence spray of metribuzin @ 0.75 kg ha^{-1} (11.79 t ha^{-1}) (Plate 1) . Same trend was also recorded in total tuber yield i.e., pre-emergence spray of metribuzin @ 0.75 kg ha^{-1} recorded highest total tuber yield of 14.29 t ha^{-1}, which was on par at post-emergence spray of metribuzin @ 0.75 kg ha^{-1} (13.71 t ha^{-1}) (Figure 1). Year wise data regarding marketable, un-marketable and total tuber yield were presented in Table 2. The analysis of variance showed that number of total tubers plant^{-1} was significantly affected by the weed management practices (Kebede et al., 2016). It is evident from the data that the marketable yield was significantly affected by various weed control treatments. The lowest un-marketable tuber yield was evolved in treatment T_1: weed check 1.51 t ha^{-1}, which was on par with T_3: Hand weeding at 30 days (1.43 t ha^{-1}). These findings are also supported by Singh et al. (2007), who also found higher number of tubers under different weed control treatments as compared to weedy check. Lavlesh et al. (2018) reported maximum marketable yield (353.01 q ha^{-1}) was in the treatment of T_2 weed free, which was found statistically at par with rest of the treatments. Whereas, the minimum marketable tuber yield (259.36 q ha^{-1}) was observed in treatment with weedy check, which was statistically at par with treatment with hand weeding at 50 DAP, treatment with hand weeding at 40 DAP and treatment with hand weeding at 30 DAP. These findings are in accordance with the Karimmojeni et al. (2014) who reported that weeds must be controlled during the first 3 weeks of potato growing seasons in order to prevent yield losses.

Plate 1: View of the effect of herbicide on weed management in potato treatments T_6 and T_7

Three years data indicated that, the lowest number of weeds were noticed in treatment T6: Pre-emergence spray of metribuzin @ 0.75 kg ha^{-1} (7.48 m^{-2}) which was on par with treatment T2: Weed free (7.60 m^{-2}) (Table 1). In another study, Lavlesh et al. (2018) reported lowest number of monocot and dicot weeds meter^{-2} in treatment of weed free because of the season long weed free condition.

The data regarding the economics of various weed control treatments on potato for 2014, 2015 and 2017 have been presented in Table 3, 4 and 5 respectively. The pooled data of benefit cost ratio of three years (Table 2) indicated that pre-emergence spray of Metribuzin @ 0.75 kg ha^{-1} (1 ml l^{-1}) recorded benefit cost ratio of 1.55, which was at par with

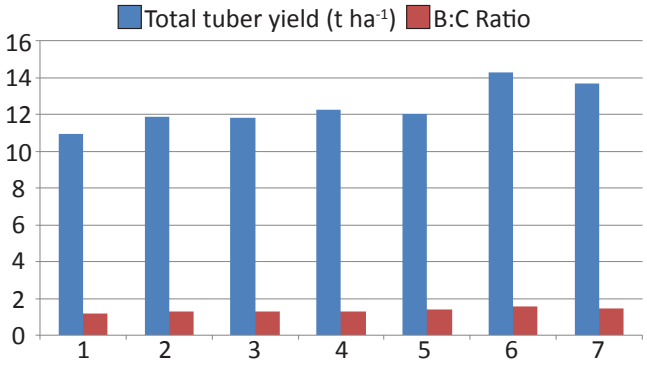

Figure 1: Effect of herbicide on weed management in potato on total tuber yield (t ha^{-1}) and B:C ratio

Table 2: Effect of herbicide on weed management on yield parameters of potato

Treatment details	Marketable tuber yield (t ha^{-1})				Un-marketable tuber yield (t ha^{-1})			
	2014	2015	2017	Pooled	2014	2015	2017	Pooled
T_1- Weed check	15.29	6.15	6.66	9.37	0.73	2.74	1.06	1.51
T_2- Weed free	16.21	6.58	7.84	10.21	0.72	2.55	1.62	1.63
T_3- Hand weeding at 30 days	16.71	6.57	7.54	10.27	0.74	2.28	1.27	1.43
T_4- Hand weeding at 40 days	16.08	7.22	8.41	10.57	0.81	2.38	1.61	1.60
T_5- Hand weeding at 50 days	16.94	7.32	8.26	10.83	0.89	1.75	1.02	1.22
T_6- Metribuzin @ 0.75 kg ha^{-1} (Pre-emergence)	17.48	8.13	11.34	12.32	1.05	2.82	2.19	2.02
T_7- Metribuzin @ 0.75 kg ha^{-1} (Post-emergence)	17.93	7.40	10.05	11.79	0.93	2.99	1.93	1.95
SEm±	0.36	NS	0.55	0.35	0.16	0.26	0.16	0.11
CD (p=0.05)	1.06	-	1.68	1.08	0.47	0.81	0.50	0.34
CV (%)	3.32	-	10.83	15.59	19.10	11.47	17.33	11.36

Table 2: Continue...

Treatment details	Total tuber yield (t ha^{-1})				B:C Ratio			
	2014	2015	2017	Pooled	2014	2015	2017	Pooled
T_1- Weed check	16.23	8.89	7.73	10.95	1.75	0.96	0.84	1.18
T_2- Weed free	17.10	9.13	9.46	11.90	1.84	0.98	1.02	1.28
T_3- Hand weeding at 30 days	17.97	8.63	8.81	11.80	1.94	0.93	0.95	1.27
T_4- Hand weeding at 40 days	17.12	9.59	10.02	12.24	1.85	1.04	1.08	1.32
T_5- Hand weeding at 50 days	18.01	10.10	10.00	12.05	1.95	1.09	1.19	1.41
T_6- Metribuzin @ 0.75 kg ha^{-1} (Pre-emergence)	18.64	10.70	13.52	14.29	2.02	1.16	1.46	1.55
T_7- Metribuzin @ 0.75 kg ha^{-1} (Post-emergence)	18.75	10.40	11.98	13.71	2.03	1.12	1.30	1.48
SEm±	0.29	0.86	0.59	0.45	-	-	-	-
CD (*p*=0.05)	0.88	1.87	1.82	1.39	-	-	-	-
CV (%)	12.59	7.21	9.89	11.23	-	-	-	-

NS: Non significant

Table 3: Cost economics of weed management in potato ha^{-1} (*Kharif*-2014)

Treatment details	Yield (t ha^{-1})	Cost of cultivation (INR ha^{-1})					Income (INR ha^{-1})		B:C Ratio
		Seed tuber cost	Fertilizers + Pesticides cost	Weedicide and labour cost	Cultivation cost	Total expenditure	Gross income	Net income	
T_1- Weed check	16.23	22,500	17,100	0.00	52,900	92,500	1,62,300	69,800	1.75
T_2- Weed free	17.10	22,500	17,100	12,400	40,900	92,900	1,71,000	78,100	1.84
T_3- Hand weeding at 30 days	17.97	22,500	17,100	4,000	48,900	92,500	1,79,700	87,200	1.94
T_4- Hand weeding at 40 days	17.12	22,500	17,100	5,000	47,900	92,500	1,71,200	78,700	1.85
T_5- Hand weeding at 50 days	18.01	22,500	17,100	6,000	46,900	92,500	1,80,100	87,600	1.95
T_6- Metribuzin @ 0.75 kg ha^{-1} (Pre-emergence)	18.64	22,500	17,100	1,700	51,200	92,500	1,86,400	93,900	2.02
T_7- Metribuzin @ 0.75 kg ha-1 (Post-emergence)	18.75	22,500	17,100	1,700	51,200	92,500	1,87,500	95,000	2.03

Note: Seed Rate- 1500 kg ha^{-1}; Seed Tuber Cost - INR 15 kg^{-1}; Market Sale Price -IN 10 kg^{-1}

Table 4: Cost economics of weed management in potato ha^{-1} (*Kharif*-2015)

Treatment details	Yield (t ha^{-1})	Cost of cultivation (INR ha^{-1})					Income (INR ha^{-1})		B:C Ratio
		Seed tuber cost	Fertilizers + Pesticides cost	Weedicide and labour cost	Cultivation cost	Total expenditure	Gross income	Net income	
T_1- Weed check	8.89	22,500	17,100	0.00	52,900	92,500	88,900	-3,600	0.96
T_2- Weed free	9.13	22,500	17,100	12,400	40,900	92,900	91,300	-1,600	0.98
T_3- Hand weeding at 30 days	8.63	22,500	17,100	4,000	48,900	92,500	86,300	-6,200	0.93
T_4- Hand weeding at 40 days	9.59	22,500	17,100	5,000	47,900	92,500	95,900	3,400	1.04
T_5- Hand weeding at 50 days	10.10	22,500	17,100	6,000	46,900	92,500	1,01,000	8,500	1.09
T_6- Metribuzin @ 0.75 kg ha^{-1} (Pre-emergence)	10.70	22,500	17,100	1,700	51,200	92,500	1,07,000	14,500	1.16
T_7- Metribuzin @ 0.75 kg ha^{-1} (Post-emergence)	10.40	22,500	17,100	1,700	51,200	92,500	1,04,000	11,500	1.12

Note: Seed Rate- 1500 kg ha^{-1}; Seed Tuber Cost - INR 15 kg^{-1}; Market Sale Price -IN 10 kg^{-1}

Table 5: Cost economics of weed management in potato ha^{-1} (*Kharif*-2017)

Treatment details	Yield (t ha^{-1})	Cost of cultivation (INR ha^{-1})					Income (INR ha^{-1})		B:C Ratio
		Seed tuber cost	Fertilizers + Pesticides cost	Weedicide and labour cost	Cultivation cost	Total expenditure	Gross income	Net income	
T_1- Weed check	7.73	22,500	17,100	0.00	52,900	92,500	77,300	-15,200	0.84
T_2- Weed free	9.46	22,500	17,100	12,400	40,900	92,900	94,600	1,700	1.02
T_3- Hand weeding at 30 days	8.81	22,500	17,100	4,000	48,900	92,500	88,100	-4,400	0.95
T_4- Hand weeding at 40 days	10.02	22,500	17,100	5,000	47,900	92,500	1,00,200	7,700	1.08
T_5- Hand weeding at 50 days	10.00	22,500	17,100	6,000	46,900	92,500	1,00,000	17,500	1.08
T_6- Metribuzin @ 0.75 kg ha^{-1} (Pre-emergence)	13.52	22,500	17,100	1,700	51,200	92,500	1,35,200	42,700	1.46
T_7- Metribuzin @ 0.75 kg ha-1 (Post-emergence)	11.98	22,500	17,100	1,700	51,200	92,500	1,19,800	27,300	1.30

Note: Seed Rate- 1500 kg ha^{-1}; Seed Tuber Cost - INR 15 kg^{-1}; Market Sale Price -IN 10 kg^{-1}

post-emergence spray of Metribuzin @ 0.75 kg ha^{-1} (1.48). The results are in agreement with the findings of Lavlesh et al. (2018) who documented highest benefit cost ratio of 1.93 was procured with treatment of metribuzin @ 0.75 kg a.i. ha^{-1} pre emergence herbicide. Mukherjee et al. (2012) also found that application of metribuzin @ 0.30 kg ha^{-1} (early post-emergence) or pendimethalin @ 0.60 kg ha^{-1} (pre-emergence) treatment in ridge planted potato followed by earthing-up at 45 DAP as effective measure for controlling weeds, getting higher production and profitability.

4. Conclusion

In the present investigation, it was found that there is a significant effect of different weed control treatments on the yield of potato tubers. Among the different treatments, pre-emergent followed by post emergent spray of metribuzin @ 0.75 kg ha^{-1} (1 ml l^{-1}) can be considered as an effective management practice for controlling weeds during *kharif* season for potato cultivation in Southern Dry Zone of Karnataka.

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