Indian Journal of Weed Science **53**(1): 54–58, 2021

Print ISSN 0253-8040 Online ISSN 0974-8164

Bio-efficacy of weed management practices in rainfed potato

S.K. Yadav*, T.K. Bag[1], A.K. Srivastava[2] and V.P. Yadav[3]

ICAR- Central Potato Research Station, Shillong, Meghalaya 793 009, India

**ICAR-Indian Institute of Sugarcane Research, Lucknow, Uttar Pradesh 226002, India*

[1]ICAR-Indian Agricultural Research Institute, New Delhi 110012, India

[2]ICAR-Indian Institute of Pulses Research, Kanpur, Uttar Pradesh 208024, India

[3]Chandra Shekhar Azad University of Agriculture & Technolog Kanpur, Uttar Pradesh 208002, India

**Email: sanjaybhu05@rediffmail.com*

Article information

DOI: 10.5958/0974-8164.2021.00007.1

Type of article: Research article

Received : 19 August 2020
Revised : 8 February 2021
Accepted : 10 February 2021

Key words
Herbicide
Metribuzin
Potato
Tuber crop

ABSTRACT

A field experiment was conducted during 2013-14, 2014-15 and 2015-16 at ICAR-Central Potato Research Station, Shillong to evaluate the bio-efficacy of weed management practices in rainfed potato under North-Eastern hill region of India. Maximum potato tubers yield (21.3 t/ha) was recorded under weed free treatment followed by metribuzin application 0.75 kg/ha as a pre-emergence (PE). Reduction in crop yield due to presence of weeds was 54.0 per cent. Maximum uptake of nutrients, *viz*. nitrogen (113.2 kg/ha), phosphorus (14.5 kg/ha) and potassium (89.4 kg/ha) were recorded by the potato under weed free *fb* application of metribuzin 0.75 kg/ha as a PE. The highest net returns (₹ 176100/ha) and B:C ratio (2.3) were recorded under the metribuzin application 0.75 kg/ha. Thus, application of metribuzin 0.75 kg/ha as PE was found more effective in potato under the rainfed ecosystem of North-Eastern hill region of India.

INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the most important cash crop in the North-Eastern hill region of India. The per capita consumption of potato in the Meghalaya is three times higher than the national average but the average productivity of potato in this region is almost half of the country. There are several constraints in potato production in this land lock region, of which weeds are the severe biotic constraint and cause more reduction in productivity of potato. Weeds pose a serious problem in potato crop in the North-Eastern hill region of India due to high rainfall during crop growth season accompanied by slow emergence of potato crop during initial stage, which become favourable for profuse growth and development of weeds in the field. Weed emergence is directly related to the intensity of rainfall to wet the soil horizons. Weeds compete with potato crop for nutrient, solar radiation, moisture and also act as host plants and source of diseases (Singh 2016) and insects (Capinera 2005). Mechanical weeding is tedious during rainy season and prone to spread of virus disease from infested plant to healthy plant (Yadav and Srivatava 2014). Yield losses in potato tubers due to weed infestation have been found 34.4 to 86.0% (Monteiro *et al*. 2011 and Yadav *et al*. 2014). Depletion of soil fertility due to presence of weeds in the potato fields is another indirect major losses caused by the weeds besides the direct monetary loss of poor yield of potato crop. Extent of depletion of soil nutrients has not been worked out in this land lock region which needs to become essential to maintain fertility of soil for higher productivity of potato. Keeping this in view, an experiment was conducted to evaluate the bio-efficacy of weed management practices on productivity of potato under rainfed condition of North-Eastern hill region of India.

MATERIALS AND METHODS

A field experiment was conducted under AICRP on potato during 2013-14, 2014-15 and 2015-16 at ICAR-Central Potato Research Station, Shillong, Meghalaya. The geographical coordinates of fixed experimental field are 25°54’ N latitude and 91°84’ E longitude and an altitude of 1739 m above mean sea level. The trial was laid out in randomized block design, replicated fourth, with 7 treatments, *viz*. weedy check (no weed control measure were followed); weed free (weekly or as per require manual weeding to make plot weed free), hand weeding at 30 days and weed free up to maturity;

hand weeding at 40 days and weed free up to maturity; hand weeding at 50 days and weed free up to maturity; metribuzin 0.75 kg/ha as pre-emergence (PE) and metribuzin 0.75 kg/ha as post-emergence (PoE) at 10% of plant-emergence.

The soil was sandy loam in the texture having acidic reaction (pH 5.12), moderately fertile, being high in organic carbon (1.84) and medium in available nitrogen (293.9 kg/ha) while low in available phosphorus (11.5 kg/ha) and high in available potassium (290.3 kg/ha). Maximum temperature varied between 20 and 26°C during crop seasons. Similarly, minimum temperature varied between 7 and 18°C. In weed free check treatment, weeding was done weekly by manual labour as and when the weeds emerged in the field. The crop was planted during the month of March with the onset of rainfall. The recommended dose of fertilizer was applied in this experiment for this region 140: 120: 60 kg/ha N, P_2O_5 and K_2O, respectively. Half dose of nitrogen and full dose of P and K were applied at the time of planting, while remaining dose of nitrogen was given at the time of earthing up. The most popular variety of potato of this region *i.e. 'Kufri Jyoti'* was taken for this experiment. The other recommended package of practices for potato was followed as per recommendation of this crop in the North-Eastern hill region of India like two spray of mancozeb and one spray of curzate (cymoxanil 8% + mancozeb 64%) were used for controlling the most devastating disease of potato *i.e.* late blight. The crop was harvested at around 120 days after planting in the last week of July.

The herbicides were applied using knap-sack sprayer fitted with flat-fan nozzle and using 800 litres of water/ha. Density of weeds (g/m^2) was taken using quadrates at 30, 40, 50, 60, 90 and 120 (at harvest) days after planting in each plot after removing the weeds from the base. Weed dry matter was determined after drying the weeds samples at 80°C for 48 hours by maintaining constant moisture content in the weed samples. The weed counts were subjected to square root transformation ($\sqrt{x+0.5}$) to normalize the distribution. Weed index and weed control efficiency was calculated as per the standard method (Yadav *et al.* 2015) at the harvest of the crop. The calculated values of the treatments and error variance ratio were compared with Fisher and Yates F Table at 5 per cent level of significance. The differences between significant treatments means were tested against CD at 5 percent probability.

RESULTS AND DISCUSSION

Weed species

The prominent weed species found in potato field were grouped in two categories like broad-leaves and narrow-leaves weeds. The major broad-leaves weeds were *Hydrocotyle javanica, Plantago major, Potentilla kleiniana, Oxalis corniculata, Senecio densiforus, Oxalis griffithii, Polygonum alatum, Solanum khasiana,* as broad-leaved weeds while *Spergula arvensis, Cyperus cyperoides, Arundinella nepalensis, Arundinella khasiana, Digitaria adscendens, Imperata cylindrica, Commellina diffusa, Arthraxon* sp. *Brachiaria reptans, Capillipedium assimile, Paspalum orbiculare* and other *Cyperus* sp, were narrow-leaves weeds found in potato field.

Weed density

The data on weed density at different stages presented in **Table 1** shown that the no. of total weed density per unit area increased gradually with duration of crop in each treatment. However, the maximum total density (587/m^2) of weeds per unit area were recorded at harvest (120 DAP) in weedy check as compared to other treatments. While minimum density of weed per unit area was noticed in weed free treatment followed by metribuzin (at 0.75 kg/ha) either as PE or at 10% of plant-emergence. Initially very low density of weeds was recorded in metribuzin than manual weeding. However, total weed density was found comparatively lower in metribuzin applied treatment than manual weeding.

Table 1. Effect of weed management practices on density of weed in potato (mean over three years)

Treatment	Total weed density (no./m^2)					
	30 DAP	40 DAP	50 DAP	60 DAP	90 DAP	120 DAP
Hand weeding at 30 days and weed free up to maturity	276.5	0.0	0.0	0.0	0.0	0.0
Hand weeding at 40 days and weed free up to maturity	270.3	291.3	0.0	0.0	0.0	0.0
Hand weeding at 50 days and weed free up to maturity	269.7	293.0	313.3	0.0	0.0	0.0
Metribuzin 0.75 kg/ha as PE	14.0	18.8	20.7	23.0	33.0	36.3
Metribuzin 0.75 kg /ha as PoE at 10% of plant-emergence	14.7	20.7	20.2	24.7	35.0	37.3
Weedy check	274.9	299.7	351.0	365.7	483.7	587.0
Weed free	0.0	0.0	0.0	0.0	0.0	0.0
LSD (p=0.05)	2.66	4.80	35.6	1.68	2.52	1.97

Weed biomass

Maximum dry weight (143.3 g/m^2) of weed biomass per unit area at harvest was recorded in weedy check as compared to other treatments. While minimum dry weight of weed biomass per unit area was recorded in weed free treatment followed by metribuzin (at 0.75 kg/ha) either as PE or at 10% of plant-emergence (**Table 2**). Initially very low dry matter of weed was recorded in metribuzin than manual weeding. However, weed biomass was found comparatively lower in metribuzin applied treatment than manual weeding. Hand weeding after 30 DAP was found more effective to reduce dry weight of weed biomass as compared to 40 and 50 DAP and weed free treatment. This might be due to that the weed control during initial period is more effective than making weed free at later stages. Similar result was also reported by Yadav *et al.* (2016).

Tuber yield

The lowest tuber yield (9.8 t/ha) of potato was recorded under weedy check (**Table 3**). The variations among yield at different treatments were recorded in the range of 9.8 to 21.3 t/ha. Similarly, the highest yield of potato (21.3 t/ha) was recorded under weed free treatment followed by metribuzin at 0.75 kg/ha as a PE application (20.0 t/ha). However, both the treatments were at par to each other but significantly superior to other treatments except application metribuzin 0.75 kg/ha as PoE at 10% of plant-emergence. Bio-efficacy of metribuzin was found more effective as compared to the other treatment except weed free treatment due to controlling the weeds during initial stage to maturity of crop. This result was also with conformity of Mishra *et al.* (2002) and Mukherjee *et al.* (2012).

Weed index and weed control efficiency

Weed index is the reduction in crop yield due to presence of weeds in comparison with weed-free check, which is an ideal parameter to judge the bio-efficacy of a particular herbicide or weed management practices in the associated crop (Yadav *et al*. 2016). The weed index among different treatments was found to be in the range of 0-54%. The maximum reduction in crop yield due to presence of weeds by 54% was found under weedy check plot followed by manual hand weeding at 50 days and weed free upto maturity compared to weed free treatment **(Table 3).** Application of metribuzin 0.75 kg/ha either PE or PoE at 10% of plant-emergence followed by manual hand weeding was found more effective to control the weeds in the potato crop. Similar result was also reported by Yadav *et al*. (2013).

The highest weed control efficiency (WCE) was recorded under weed free treatment followed by application of metribuzin 0.75 kg/ha as PE or PoE at 10% of plant-emergence (Singh *et al*. 2007). Hand weeding at 30 DAP and weed free upto maturity

Table 2. Impact of weed management practices on dry matter yield of weed biomass (mean over three years)

Treatment	Dry matter of weed biomass (g/m^2)					
	30 DAP	40 DAP	50 DAP	60 DAP	90 DAP	120 DAP
Hand weeding at 30 days and weed free up to maturity	7.84	0.00	0.00	0.00	0.00	0.00
Hand weeding at 40 days and weed free up to maturity	7.62	18.9	0.00	0.00	0.00	0.00
Hand weeding at 50 days and weed free up to maturity	7.27	18.4	38.5	0.00	0.00	0.00
Metribuzin 0.75 kg/ha as PE	2.30	6.30	12.3	24.5	50.2	65.2
Metribuzin 0.75 kg /ha as PoE at 10% of plant-emergence	2.50	6.40	14.0	25.1	56.2	68.5
Weedy check	7.79	18.5	38.5	56.8	115.5	143.3
Weed free	0.00	0.00	0.00	0.00	0.00	0.00
LSD (p=0.05)	0.43	1.23	2.13	3.69	2.25	7.46

Table 3. Impact of weed management practices on yield of potato and bio-efficacy parameters of weeds

Treatment	Yield (t/ha)			Pooled over 3 years		
	2013-14	2014-15	2015-16	Yield (t/ha)	Weed index (%)	Weed control efficiency (%)
Hand weeding at 30 days and weed free up to maturity	19.1	16.4	17.5	17.7	16.9	100.0
Hand weeding at 40 days and weed free up to maturity	18.2	15.2	15.8	16.4	23.0	100.0
Hand weeding at 50 days and weed free up to maturity	17.5	14.8	15.7	16.0	24.9	100.0
Metribuzin 0.75 kg/ha as PE	19.9	19.3	20.9	20.0	6.1	60.6
Metribuzin 0.75 kg /ha as PoE at 10% of plant-emergence	19.1	18.5	19.7	19.1	10.3	58.6
Weedy check	10.8	9.1	9.3	9.80	54.0	0.0
Weed free	20.3	20.9	22.8	21.3	0.0	100.0
LSD (p=0.05)	1.04	1.09	1.31	1.10	-	-

recorded the highest WCE. The range of WCE among different weed management practices varied between 58.6 to 100% over the weedy check

Nutrient uptake

Maximum uptake of nutrient, *viz*. nitrogen (113.2 kg/ha), phosphorus (14.5 kg/ha) and potassium (89.4 kg/ha) by potato was recorded with weed free treatments followed by application of metribuzin 0.75 kg/ha as PE which was found significantly superior over other treatments (**Table 4**). Prasad and Singh (1995) reported that adoption of weed control measures significantly increased the NPK uptake by the crop compared with the weedy control. The minimum uptake of the major nutrients (NPK) was recorded under weedy check treatment. This might be due to poor yield of potato under weedy check treatment. Higher yield was directly proportional to the quantity of nutrients uptake either by crop or weeds. More uptake of nutrient by the crop indicated the higher yield and better competitiveness of crop against weeds. Better competitiveness of crop also reduces the losses of nutrients in the form of uptakes by the weeds. Because of the higher bio-efficacy of weed management practices emphasised the uptake of nutrients by the crops and reducing the uptake of nutrients by the weeds. In contrast to weedy check treatment where uptake of nutrients was found more by the weeds than the crop. This indicates there was wastage of nutrients by the weeds instead of utilization of nutrients by the potato crop.

Nutrient balance sheet

Maximum improvement in nutrient balance was recorded under the hand weeding at 50 DAP and weed free (**Table 5**). The competition between potato and weeds was higher due to presence of weeds upto 50 days crop growth stage (Karimmojeni *et al.* 2014). Both potato and weeds were recorded lower uptake of nutrients as compared to other treatments. This might be due to lower dry matter of weeds resulted in poor uptake of nutrient from the soil. Similarly, poor yield of potato due to presence of weeds resulted in poor uptake of nutrients by potato crop. As per treatments, weeding was done at 50 days after planting as just before maturity of weeds resulted in poor uptake of nutrients from the soil. Ultimately total uptake of nutrients was lower than other treatments (besides application of same recommended dose of fertilizers to potato in each treatment) resulted in more build-up of applied unutilized soil nutrients. The proportion of nutrient uptake in total uptake was found more by weeds than potato in weedy check treatments. This was might be due to lower yield of potato due to presence of weeds.

Economics

Application of metribuzin (at 0.75 kg/ha) reduced the cost of potato cultivation as compared to weed free check (**Table 6**). Weed free check required more labour for manual weeding when compared with herbicides application resulting in the higher cost of cultivation. Lower cost of cultivation and higher

Table 4. Impact of weed management practices on nutrient uptake (NPK) by potato and weed (pooled over 3 years)

Treatment	Nutrient uptake by potato kg/ha)			Nutrient uptake by weeds(kg/ha)		
	N	P	K	N	P	K
Hand weeding at 30 days and weed free up to maturity	96.6	12.6	76.7	1.1	0.3	1.1
Hand weeding at 40 days and weed free up to maturity	80.8	10.6	64.5	7.3	1.7	7.0
Hand weeding at 50 days and weed free up to maturity	74.8	10.2	59.7	8.9	2.2	9.0
Metribuzin 0.75 kg/ha as PE	112.1	14.2	86.9	7.5	1.7	7.3
Metribuzin 0.75 kg /ha as PoE at 10% of plant-emergence	106.0	13.2	82.5	7.8	1.8	7.7
Weedy check	43.3	5.4	33.9	56.7	13.0	51.9
Weed free	113.2	14.5	89.4	0.1	0.0	0.1
LSD (p=0.05)	4.6	0.5	3.5	2.4	1.0	2.7

Table 5. Effect of weed management practices on nutrients balance sheet (kg/ha) of soil (pooled over 3 years)

Treatment	Total nutrient applied (kg/ha)			Total uptake of nutrient (kg/ha)			Nutrient balance (kg/ha)		
	N	P	K	N	P	K	N	P	K
Hand weeding at 30 days and weed free up to maturity	140.0	52.5	49.8	97.6	12.9	77.8	42.4	39.6	-28.0
Hand weeding at 40 days and weed free up to maturity	140.0	52.5	49.8	88.1	12.3	71.5	51.9	40.2	-21.7
Hand weeding at 50 days and weed free up to maturity	140.0	52.5	49.8	83.7	12.3	68.7	56.3	40.2	-18.9
Metribuzin 0.75 kg/ha as PE	140.0	52.5	49.8	119.6	15.9	94.2	20.4	36.7	-44.4
Metribuzin 0.75 kg /ha as PoE at 10% of plant-emergence	140.0	52.5	49.8	113.8	15.0	90.2	26.2	37.6	-40.4
Weedy check	140.0	52.5	49.8	100.0	18.4	85.8	40.0	34.1	-36.0
Weed free	140.0	52.5	49.8	113.3	14.6	89.5	26.7	38.0	-39.7
LSD (p=0.05)	-	-	-	4.6	0.9	2.9	3.5	3.3	-3.4

Table 6. Economics of weed management practices in potato (×10³ `/ha) (pooled over 3 years)

Treatment	Seed	Fertilizers	Cultivation	Total cost	Net returns	B:C ratio
Hand weeding at 30 days and weed free up to maturity	30.0	14.3	50.4	94.7	117.8	1.2
Hand weeding at 40 days and weed free up to maturity	30.0	14.3	46.9	91.2	106.9	1.2
Hand weeding at 50 days and weed free up to maturity	30.0	14.3	43.5	87.7	104.0	1.2
Metribuzin 0.75 kg/ha as PE	30.0	14.3	30.8	75.0	176.1	2.3
Metribuzin 0.75 kg/ha as PoE at 10% of plant-emergence	30.0	14.3	30.8	75.0	164.9	2.2
Weedy check	30.0	14.3	27.8	72.1	46.5	0.6
Weed free	30.0	14.3	62.9	107.1	164.7	1.5
LSD (p=0.05)	-	-	3.2	2.4	6.8	0.3

yield in metribuzin application resulted in more net returns than other treatments. The maximum net returns (₹ 176100/ha) and the highest B:C ratio (2.3) was recorded under metribuzin application 0.75 kg/ha as a PE followed by metribuzin 0.75 kg/ha as a PoE at 10% of plant-emergence. Similar result was also reported by Channappagoudar *et al.* (2007)

It may be concluded that application of metribuzin 0.75 kg/ha either PE or as PoE at 10% of plant-emergence was found more effective to control the weeds in potato under the rainfed ecosystem of North-Eastern hill region of India.

REFERENCES

Capinera JL. 2005. Relationships between insect pests and weeds: an evolutionary perspective. *Weed Sciences* **53**(6): 892-901.

Channappagoudar BB, Biradar NR, Bharmagoudar TD and Koti RV. 2007. Crop weeds competition and chemical control of weeds in potato. *Karnataka Journal of Agricultural Sciences* **20**(4): 717-718.

Gugala M and Zarzecka K. 2013. Relationship between potato yield and the degree of weed infestation. *African Journal of Agricultural Research* **8**(46): 5752–5758.

Karimmojeni H, Barjasteh A, Mousavi RS and Bazrafshan AH. 2014. Determination of critical period of weed control in potato (*Solanum tuberosum* L.). *New Zealand Journal of Crop and Horticultural Sciences* **42**(3): 151–160.

Mishra JS, Singh VP and Yaduraju NT. 2002. Effect of methods of planting and metribuzin on weed growth and yield of potato (*Solanum tuberosum*) under *Vertisols*.*Indian Journal of Agricultural Sciences* **72**(5): 292–294.

Monteiro A, Henriques I and Moreira I. 2011. Critical period for weed control in potatoes in the Huambo province (Angola). *Planta Daninha* **29**(2): 351–362.

Mukherjee PK, Rahaman S, Maity SK and Sinha B. 2012. Weed management practices in potato (*Solanum tuberosum* L). *Journal of Crop and Weed* **8**(1): 178–180.

Prasad K and Singh RS. 1995. Influence of weed-control measures on weed growth, nutrient uptake and tuber yield of potato *(Solanum tuberosum). Indian Journal of Agricultural Sciences* **65**(1): 46–48.

Singh B. 2016. Survey and indexing of weeds growing around potato fields for their role as an inoculum source for potato leaf roll virus (PLRV).*British Biotechnology Journal* **16**(1): 1–8.

Singh Moolchand, Prabhukumar S, Sairam CV and Hanji MB. 2007. Evaluation of different herbicides for weed control in potato. *Indian Journal of Weed Sciences* **39**(3&4): 223–226.

Yadav SK and Srivastava AK. 2014. A review on agronomical aspects of potato production in north-eastern region of India. *International Journal of Applied and Pure Science and Agriculture* **1**(6): 26–34.

Yadav SK, Lal SS, Srivastava AK, Bag TK and Singh BP. 2015. Efficacy of chemical and non-chemical methods of weed management in rainfed potato (*Solanum tuberosum* L.). *Indian Journal of Agricultural Sciences* **85**(3): 382–386.

Yadav SK, Srivastava, AK, Gurjar MS and Bag TK. 2013. Major weeds of potato and thier management in Meghalalya hills. *AgrobiosNewslwtter* **11**(10): 45–46.

Yadav SK, Lal SS, Srivastava AK and Bag TK. 2014. A review on weed management in potato (*Solanum tuberosum*) in north eastern hill region of India. *International Journal of Agriculture. Photon* **125**: 279–284.

Yadav SK, Govindakrshanan PM, Dua VK and Bag TK. 2016. Effect of weed management practices on potato in NEH region of India, pp. 430–431. In: *4th International Agronomy Congress* held at New Delhi from 22-26th November 2016.