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A new formulation of metribuzin for weed control in potato

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Abstract

A field investigation was carried out during the winter seasons of 2005 and 2006, to study the efficacy of 'Mahamaya' a new formulation of metribuzin for controlling weeds in potato. Five 'Mahamaya' doses at 0.4, 0.5, 0.6, 1.0 and 2.0 kg a.i./ha were evaluated in comparison to "Sencor", the popular formulation of metribuzin at 0.5 kg a.i./ha, pendimethalin at 1.0 kg/ha, hand weeding twice and weedy check. *Phalaris minor* (52.4%), *Coronopus didymus* (16.1%), *Anagallis arvensis* (11.2%), *Avena ludoviciana* (10.7%), *Vicia sativa* (7.3%) and *Lolium temulentum* (2.3%) were the predominant weeds. 'Mahamaya' at 0.5 and 0.6 kg a.i./ha was as effective as pendimethalin at 1.0 kg/ha and 'Sencor' at 0.5 kg a.i./ha in controlling *P. minor*, *C. didymus*, *A. ludoviciana*, *A. arvensis* and *V. sativa*. However, at 0.5 and 0.6 kg a.i./ha, 'Mahamaya' significantly increased potato tuber yield over hand weeding and 'Sencor' at 0.5 kg a.i./ha. At higher rates (1.0 and 2.0 kg a.i./ha), 'Mahamaya' was phytotoxic especially during 2005. 'Mahamaya' at 0.5 kg a.i./ha resulted in highest net returns over weedy check (Rs 69946/ha) and marginal benefit cost ratio (MBCR, 51.8). This was followed by 'Mahamaya' at 0.60 kg a.i./ha and pendimethalin at 1.0 kg/ha for net returns and 'Mahamaya' at 0.4 and 0.6 kg a.i./ha, pendimethalin 1.0 kg/ha and 'Sencor' at 0.5 kg a.i./ha for MBCR. Potato tuber yield was negatively associated with weed biomass. The economic threshold of weeds based upon prevalent prices incurred on treatments and crop production varied between 4.5-28.0 g of weed biomass production per m^2. 'Mahamaya' at 0.5 kg a.i./ha had highest weed management index.

Key words: Potato, weeds, herbicide formulation, yield, returns.

Introduction

The effectiveness of a herbicide has greatest bearing on the formulation and the type of adjuvants added. Several herbicides are used for weed control in potato. Metribuzin is quite effective against weeds in potato (Mishra *et al.*, 2002 and Pandey *et al.*, 2002). 'Sencor' is the most commonly used formulation of metribuzin. A new formulation "Mahamaya" has recently been released for commercial application. But before it goes in the hands of farmers, it is pertinent to study its efficacy and economic viability in relation to the popular formulation and other herbicides in potato. Therefore, the present investigation was carried out to study the efficacy of the new formulation of metribuzin at different rates for controlling weeds in potato.

Material and Methods

A field investigation was carried out during the winter seasons of 2005 and 2006 at CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur. The soil of the experimental site was silty clay loam in texture, acidic in reaction, medium in available N, P and K contents. Nine treatments consisting of five 'Mahamaya' rates (0.4, 0.5, 0.6, 1.0 and 2.0 kg a.i./ha), pendimethalin at 1.0 kg/ha, 'Sencor' at 0.5 kg a.i./ha, hand weeding twice (60 & 90 days after planting, DAP) and weedy check were tested in randomized block design with three applications. Herbicides were applied with backpack power sprayer using 600 l water/ha immediately after planting potato. Potato variety 'Kufri Jyoti' was planted on 18 January 2005 and 10 January 2006 and harvested on 31 May 2005 and 21 May 2006. Except weed control, the crop was raised in accordance with the recommended package of practices. Count of weeds was recorded at 100 and 130 DAP. The count data was analyzed after subjecting 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 of the treatments was computed based upon the prevalent market prices.

Weed control efficiency (WCE) and weed management index (WMI) were worked out as per the formulae given below,

WCE (%) = [(Dry weight of weeds in weedy check - dry weight of weeds in treated plot)/ dry weight of weeds in weedy check] x 100

WMI = Percent yield over weedy/ per cent control of weed

Economic thresholds (Economic injury levels) were determined by the methods of Stone and Pedigo (1972) as below,

Economic threshold = Gain threshold/ Regression coefficient

Where, Gain threshold = Cost of weed control/ Price of produce, and regression coefficient (B is the outcome of simple linear relationship between yield (Y) and weed biomass (X), Y = A + BX.

Results and Discussion

Phalaris minor was the predominant weed constituting 52.4 per cent of the total population of the weeds in the weedy check at the maximum population stage (100 DAS). The other important weeds were, *Coronopus didymus* (16.1%), *Anagallis arvensis* (11.2 %), *Vicia sativa* (7.3 %), *Avena ludoviciana* (10.7 %) and *Lolium temulentum* (2.3 %).

All the weed control treatments were significantly superior to weedy check in reducing the count of *P. minor* at 100 and 130 days after planting during both the years (Table 1). Count of *P. minor* was significantly lower owed to hand weeding twice at 100 days after sowing during both the years and was at par with 'Mahamaya' at 0.5 and 1.0 kg a.i./ha during both the years and 'Mahamaya' at 0.6 and 2.0 kg a.i./ha and 'Sencor' 0.5 kg a.i./ha during 2006. However, all the herbicidal treatments were as good as hand weeding twice in reducing the count of *P. minor* at 130 DAP during both the years. Pandey (2002) reported metribuzin at 200 g/ha, the most effective herbicide against *P. minor* with 94% control, while pendimethalin gave moderate control of *P. minor*. Similarly, all weed control treatments were statistically equal in influencing the count of *C. didymus* at 100 days after planting during both the years and 130 days during 2005, *A. ludoviciana* at 100 DAP in 2006, *A. arvensis* at 100 DAP in 2006 (Table 2) and *V. sativa* at 100 DAP in 2005. Effective control of *V. sativa*, *Lolium* sp (Retzinger and Richard 1983) and *C. didymus* (Pandey 2002) with metribuzin or hand weeding twice has been documented.

Owing to species-wise reduction in the population of weeds, all the weed control treatments brought about significant reduction in total weed dry matter accumulation over weedy check during both the years (Table 3).

Table 1. Effect of treatments on count (No m^{-2}) of *Phalaris*, *Vicia* and *Coronopus* in potato

Treatment	Rate (kg a.i. /ha)	*P. minor*				*C. didymus*				*V. sativa*			
		2005		2006		2005		2006		2005		2006	
		100 DAP	130 DAP	100 DAP	130 DAP	100 DAP	130 DAP	100 DAP	130 DAP	100 DAP	130 DAP	100 DAP	130 DAP
'Mahamaya'	0.4	2.4 (5.3)	2.7 (6.6)	2.9 (8.0)	2.1 (4.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.8 (4.0)	2.0 (4.0)	1.0 (0.0)	4.2 (17.3)	1.0 (0.0)
'Mahamaya'	0.5	1.8 (2.6)	2.3 (5.3)	1.8 (2.7)	2.1 (4.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.4 (1.3)	1.8 (2.6)	1.6 (2.6)	1.6 (2.4)	1.0 (0.0)
'Mahamaya'	0.6	2.4 (5.3)	2.5 (6.6)	2.2 (6.7)	2.5 (6.7)	1.0 (0.0)	1.0 (0.0)	1.4 (1.3)	1.4 (1.3)	1.6 (2.6)	1.4 (1.3)	2.4 (5.3)	1.0 (0.0)
'Mahamaya'	1.0	2.0 (4.0)	1.8 (2.6)	1.0 (0.0)	1.7 (2.7)	1.0 (0.0)	1.4 (1.3)	1.0 (0.0)	1.0 (0.0)	2.0 (4.0)	1.0 (0.0)	1.4 (1.3)	1.0 (0.0)
'Mahamaya'	2.0	2.2 (5.3)	2.5 (6.6)	2.3 (5.3)	1.4 (1.3)	1.4 (1.3)	1.4 (1.3)	1.0 (0.0)	1.0 (0.0)	1.4 (1.3)	1.4 (1.3)	1.8 (2.7)	1.0 (0.0)
'Sencor'	0.5	4.3 (18.6)	1.8 (4.0)	2.5 (6.7)	1.0 (.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	2.2 (5.3)	1.4 (1.3)	1.9 (4.0)
Pendimethalin	1.0	2.4 (5.3)	1.4 (1.3)	2.9 (8.0)	1.9 (4.0)	1.0 (0.0)	1.4 (1.3)	1.0 (0.0)	1.4 (1.3)	1.0 (0.0)	1.4 (1.3)	5.9 (34.6)	2.8 (6.7)
Hand weeding		1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	2.3 (5.3)	1.0 (0.0)	1.0 (0.0)	1.9 (4.0)	1.7 (2.7)	1.0 (0.0)	1.0 (0.0)	1.7 (2.7)	1.4 (1.3)
Weedy	-	8.5 (72.0)	6.2 (38.6)	8.5 (70.7)	4.9 (24.0)	4.5 (21.3)	4.0 (16.0)	4.8 (22.7)	2.7 (6.7)	3.8 (9.3)	2.9 (8.0)	3.4 (10.7)	2.8 (6.7)
CD (P= 0.05)	-	1.2	1.8	1.7	1.8	1.1	0.9	1.1	NS	1.2	NS	1.3	1.0

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

Hand weeding twice (60 and 90 DAP) significantly lowered the total weed dry matter accumulation and resulted in highest WCE of 96%.

'Mahamaya' at 0.4, 0.5, 1.0 and 2.0 and pendimethalin 1.0 kg/ha were as effective as hand weeding twice in reducing year-wise and mean total weed dry matter accumulation with WCEs of 90-93%. Pandey *et al.* (2002) have also reported metribuzin the most effective herbicide against weeds in potato.

Because of better crop growth due to favourable climate, the potato tuber yield was better during 2006 as compared to 2005 (Table 3). 'Mahamaya' at 0.5 and 0.6 kg a.i./ha remaining at par with 'Mahamaya' at 0.4 kg a.i./ha and pendimethalin at 1.0 kg/ha resulted in significantly higher mean tuber yield of potato over rest of the treatments.

Table 2. Effect of treatments on count (No m^{-2}) of *Avena*, *Anagalli*, and *Lolium* in potato and dry weight of total weeds

Treatment	Rate (kg a.i./ha)	*A. ludoviciana*			*A. arvensis*			*L. temulentum*	Dry weight (g m^{-2})		
		2005	2006		2005	2006		2006	2005	2006	Mean
		100 DAP	100 DAP	130 DAP	100 DAP	100 DAP	130 DAP	130 DAP			
'Mahamaya'	0.4	1.6 (2.6)	1.4 (1.3)	1.4 (1.3)	1.0 (0.0)	1.4 (0.3)	1.4 (1.3)	3.1 (9.3)	41.7	24.9	33.3
'Mahamaya'	0.5	1.8 (2.6)	1.0 (0.0)	1.9 (4.0)	1.0 (0.0)	1.0 (0.0)	2.2 (4.0)	2.5 (5.3)	25.9	12.3	19.1
'Mahamaya'	0.6	1.8 (2.6)	1.4 (1.3)	2.9 (9.3)	1.4 (1.3)	1.0 (0.0)	1.7 (2.7)	1.9 (4.0))	21.1	11.6	16.4
'Mahamaya'	1.0	1.0 (0.0)	1.4 (1.3)	1.0 (0.0)	2.2 (4.0)	1.0 (0.0)	1.0 (0.0)	1.7 (2.7)	18.7	14.0	16.3
'Mahamaya'	2.0	1.4 (1.3)	1.0 (0.0)	1.7 (2.7)	2.0 (4.0)	1.0 (0.0)	1.0 (0.0)	1.7 (2.7)	17.0	15.9	16.5
'Sencor'	0.5	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)	59.5	19.7	39.6
Pendimethalin	1.0	1.8 (2.6)	1.4 (1.3)	2.7 (8.0)	1.0 (0.0)	1.0 (0.0)	1.4 (1.3)	2.1 (4.0)	29.6	19.5	24.6
Hand weeding		1.0 (0.0)	1.0 (0.0)	1.7 (2.7)	1.0 (0.0)	1.7 (2.7)	1.0 (0.0)	1.0 (0.0)	16.3	5.9	11.1
Weedy	-	3.4 (10.6)	4. 4 (18.7)	4.3 (17.3)	4.1 (16.0)	3.9 (14.7)	1.4 (1.3)	2.7 (6.7)	307.1	196.6	251.9
CD (P=0.05)	-	NS	1.0	NS	0.79	1.0	NS	NS	15.4	16.4	15.6

Data on weed count were transformed to square root transformation ($\sqrt{x+1}$) Values in the parentheses are the means of original values.

Table 3. Effect of treatments on weed control efficiency (WCE), potato tuber yield, WMI, net return, MBCR and economic threshold

Treatments	Rate (kg a.i./ha)	WCE (%)	Potato tuber yield (q/ha)			WMI	Net return over weedy (Rs/ha)	MBCR	Economic threshhold
			2005	2006	Mean				
'Mahamaya'	0.4	86.8	197.2	236.1	216.7	1.16	53260	46.8	4.5
'Mahamaya'	0.5	92.4	227.8	273.2	250.5	1.43	69946	51.8	5.4
'Mahamaya'	0.6	93.5	225.0	273.2	249.1	1.40	69037	44.1	6.3
'Mahamaya'	1.0	93.5	147.2	254.6	200.9	0.92	44105	18.2	9.7
'Mahamaya'	2.0	93.4	158.3	259.3	208.8	1.00	45897	10.1	18.3
'Sencor'	0.5	84.4	161.1	249.7	205.4	1.07	47426	35.1	7.1
Pendimethalin	1.0	90.2	222.2	259.3	240.7	1.36	64655	36.3	5.4
Hand weeding		95.6	144.4	282.4	213.4	1.02	45778	6.5	28.0
Weedy	-	-	86.1	129.6	107.9	-	-	-	-
CD (P=0.05)	-	-	47.1	29.2	35.2	-	-	-	-

WMI, weed management index

At 0.5 kg a.i./ha, 'Mahamaya' increased potato tuber yield by 132 % over weedy check and 17% over hand weeding twice. Mishra *et al.* (2002) have reported 63.4% losses in tuber yield due to the presence of weeds and lowest weed biomass and highest tuber yields following pre-emergence

application of metribuzin. However, hand weeding twice was as good as 'Mahamaya' at 0.5 and 0.6 kg a.i./ha in influencing potato tuber yield during 2006. 'Mahamaya' and 'Sencor' at the equal rate (0.5 kg a.i./ha) resulted in significantly higher potato tuber yield. The percent increase in yield by the former over the later was 22%. Because of toxic influence on tuberization, higher doses of 'Mahamaya' (1.0 and 2.0 kg a.i./ha) inspite of controlling weeds effectively were not as effective as lower doses in influencing potato tuber yield during 2005. However, during 2006, yields owed to higher doses (1.0 and 2.0 kg a.i./ha) of Mayamaya were equal to the yields at the lower doses (0.5 and 0.6 kg a.i./ha).

In the present investigation potato tuber yield was negatively correlated with weed biomass (r= -0.682**, -0.975 and -0.900 respectively for 2005, 2006 and mean, respectively; ** denotes significance at 1% level of significance) showing high degree of association as affected due to the presence of weeds. Since weed dry weight (X) was linearly correlated at the significant level of 1%, with the potato tuber yield (Y), the relationship was given by linear equation (Y = A + BX, A being intercept and B regression coefficient) as below,

$$Y = 234.2 - 0.5003\ X$$

$$(R^2 = 0.810)$$

The statistical analysis of the regression equation explains that with every g/m^2 increase in dry weed weight, the yield was expected to decrease by 0.5 q/ha.

The economic threshold levels of weeds (dry weight/unit area) at the current prices of treatment application and crop production on the basis of weed infestation in potato are given in Table 3. The economic threshold levels with the weed management practices studied varied between 4.5 to 28.0 g per m^2. It is clearly indicated that any increase in the cost of treatment would lead to higher value of economic threshold, whereas an increase in the price of crop produce would result in lowering the economic threshold.

Weed management index (WMI) was highest for 'Mahamaya' at 0.50 kg a.i./ha (1.43) and it was closely followed by Mahamaya' at 0.60 kg a.i./ha (1.40) and pendimethalin at 1.0 kg/ha (1.36).

The better tuber yields owed to superior weed control resulted in higher net returns over weedy check due to 'Mahamaya' at 0.50 and 0.60 kg a.i./ha followed by pendimethalin 1.0 kg/ha. Compared to 'Sencor', 'Mahamaya' at 0.50 kg a.i. increased net returns over weedy check by 47.5 percent. The magnitude of increase in net return, owing to 'Mahamaya' at 0.50 kg/ha over hand weeding twice was 52.8 percent. Because of cheap application costs, MBCR was 1.6 to 8.0 times higher due to herbicidal treatments over the hand weeding twice treatment. Hamidullah Jan *et al.* (2004) have also reported similar findings. The highest MBCR was associated owing to 'Mahamaya' at 0.5 kg a.i/ha follwed by 'Mahamaya' at 0.4 and 0.6 kg a.i./ha.

Thus the present investigation conclusively inferred that application of 'Mahamaya' at 0.5 kg/ha can be a better substitution of pendimethalin at 1.0 kg/ha and an alternate of 'Sencor' at 0.5 kg/ha in controlling weeds without any phytotoxic effect in potato.

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References

Hamidullah Jan, Muhammad A and and Ali A 2004. Studies on weed control in potato in Pakhal plains of Mansehra. Pakistan J. Weed Sci. Res. **10** (3/4): 157-160.

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 J. Agric. Sci. **72** (5): 292-294.

Pandey J, Singh R and Varma AK 2002. Integrated weed management in true potato. Annals Agric. Res. **23** (3): 486-488.

Pandey J 2002.Effect of dose and mode of metribuzin application on *Phalaris minor* and yield of wheat (*Triticum aestivum*). Indian J. Agric. Sci. **72** (1): 11-13.

Retzinger EJ Jr. and Richard P 1983. Weed control in wheat with metribuzin. Proceedings, Southern Weed Science Society, 36th Annual Meeting., pp 132.

Stone JD and Pedigo LP 1972. Development and economic injury level of the green clover worm on soybean in IOWA. J. Econ. Ent. **65**: 197-201.