

Evaluation of Different Weed Management Practices in Potato (*Solanum tuberosum* L.)

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ABSTRACT

An on-farm trial was conducted at farmers' fields in the Hassan district of Karnataka during **rabi** seasons of 2006-07 and 2007-08 to find out the effective and economical integrated weed control method in potato. *Amaranthus viridis*, *Chenopodium album*, *C. murale* and *Poa annua* were the major weed species in potato field. Mulch (water hyacinth) along with application of oxadiazon (0.75 kg/ha) at seven days after planting (DAP) was found most effective in controlling weed population (94 to 95%) upto 30 days of planting than that employed by only mulch (45 to 53%). The weeds were found to reduce tuber yield to the extent of 43%. Among the weed control treatments, minimum nutrient uptake by weeds and highest tuber yield were recorded with mulching+oxadiazon (0.75 kg/ha) spray at 7 DAP+one hand weeding at 25 DAP, and these were at par with weed free check. The highest net returns of Rs. 74563 and 122859/ha and maximum benefit : cost ratio of 2.75 and 3.27 were noted in mulching with water hyacinth+herbicide application at 7 DAP+one hand weeding at 25 DAP in 2006-07 and 2007-08, respectively.

Key words : Crop-weed competition, chemical weed control, economics, herbicide efficacy

INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the most important food as well as vegetable crops of world and is capable of producing more weight and calories per unit area as compared with other crops (Dass, 1993). It is one of the most important commercial crops of Karnataka. Hassan is the major potato growing district in the state with an area of 25,000 ha producing 314750 tonnes of potato tubers with a productivity of 12.59 t/ha which contributes nearly 60% of total production of potato crop in the state (Indresh *et al.*, 2005). Intense weed competition is one of the constraints in realizing potential yield of potato resulting in substantial reduction in the yield (Singh *et al.*, 1984). Yield losses go as high as 40-65% or more due to weeds alone depending upon their infestation (Tripathi *et al.*, 1989). Besides, space, light and moisture weeds also compete for nutrients with the main crop and remove as high as 94.2 kg N, 17.1 kg P₂O₅ and 91.6 kg K₂O/ha (Prasad and Singh, 1995). Weeds not only reduce yield of potato but also hinder in mechanical operations like harvesting tubers (Knezevic *et al.*, 1995). In addition, weeds cause spread of several diseases and pests and quality of produce is also reduced by weed infestation (Pandey, 2000). Jaiswal and Lal (1996) reported that weeds reduced the tuber yield by

42% on an average, whereas weed control treatments increased the tuber yield by 18-82%. Manual weeding is quite effective, but it is time consuming, costly, tedious and may cause root injury and disturbs root system in the later stage of crop growth (Khurana *et al.*, 1993). Use of suitable herbicides alone or in combination with manual/mechanical weeding for weed control brings down weed control costs by 75-85% compared to manual weeding (Gopinath and Mina, 2009). In Hassan district, scarcity of labourers is found during crop season and labourer hikes increases cost of production. In this situation, farmers of Hassan district need a profitable technology for weed management that may solve their weeds problem. Hence, the present study was undertaken to find out a safe, effective and economical weed control method for increasing productivity of potato.

MATERIALS AND METHODS

An on-farm trial was conducted at farmers' fields in the Hassan (13°2' N latitude, 76°57' E longitude with an altitude of 957 m above mean sea level) district of Karnataka during **rabi** seasons of 2006-07 and 2007-08, respectively. The soil of trial site was sandy loam and slightly acidic in reaction (pH 6.67). The available N, P and K were 186.43, 38.55 and 198.54 kg/ha,

respectively. The experiment was laid out in a randomized complete block design with three replications. The gross plot size was 4 x 3 m. Seven weed management practices including one control were used as treatment variables. The treatments were control (weedy check), mulching with water hyacinth, mulching+one hand weeding at 25 days after planting (DAP), mulching+two hand weedings at 25 and 45 days DAP, mulching+oxadiazon (0.75 kg/ha) spray at 7 DAP as post-planting post-emergence weed control, mulching+oxadiazon (0.75 kg/ha) spray at 7 DAP+one hand weeding at 25 DAP and weed free (weeding was done manually at 20, 40, 60 and 80 DAP). The potato variety 'Kufri Jyoti' was used as test crop. Mulching with the water hyacinth was done by spreading over the plots after planting at the rate of 1.5 kg per m². The potato whole tubers were planted on 25 October in 2006 and 5 November in 2007 at a spacing of 60 x 25 cm. The crop was fertilized with 100 kg N, 80 kg P and 100 kg K/ha. Entire P and K fertilizers along with 50% N were applied at the time of planting and remaining N was top dressed at the time of earthing up. Herbicide was applied at 7 DAP through Knapsack sprayer using 100 litre water/ha. Irrigation was applied two times each at 30 and 55 DAP only in furrows. The required plant protection measures were followed as per recommendation. Data on weed density and weed biomass were taken at 90 DAP. Weed control efficiency (WCE) was calculated by using the formula (Thakral *et al.*, 1988) : $WCE \% = (\text{weed biomass in weedy check} - \text{weed biomass in managed treatment}) / \text{weed biomass in weedy check} \times 100$. Uptake of N, P and K by weeds and potato crop was calculated by multiplying the nutrient content with their respective oven-dry weights. Cost benefit analysis was done according to prevailing market price.

RESULTS AND DISCUSSION

Weed Species and Infestation

The major weeds infested the crop in the experimental trial were *Amaranthus viridis* L., *Avena fatua* L., *Chenopodium album* L., *C. murale* L., *Coronopus didymus* (L.) Sm., *Fumaria parviflora* Lam., *Poa annua* L., *Trianthema portulacastrum* L. and *Spergula arvensis* L. Among the weed species, *A. viridis*, *C. album*, *C. murale* and *Poa annua* were the dominant weeds in the field. Weed management methods like mulching, mulching plus application of herbicide was

the most effective in controlling weed population over control upto 30 DAP. Among the methods, mulching plus application of oxadiazon (0.75 kg/ha) at 7 DAP was much more effective in suppressing weeds than application of mulching only. Application of mulching plus oxadiazon (0.75 kg/ha) at 7 DAP controlled weeds by 94% during 2006-07 and 95% during 2007-08, while application of mulching suppressed weeds by 53% in 2006-07 and 45% in 2007-08.

Weed Density

Weed density was significantly influenced by different weed management practices (Table 1). The highest weed density 358 and 383/m² was recorded in untreated control plot in 2006-07 and 2007-08, respectively, and it was followed by only mulching plots (268/m² in 2006-07 and 259/m² in 2007-08). The weed density in mulching plus one hand weeding at 25 DAP and mulching plus oxadiazon (0.75 kg/ha) at 7 DAP were statistically identical. The lowest weed density (59 and 77/m²) was recorded from the plots where mulching plus two hand weedings were done at 25 and 45 DAP in both the years and it was statistically identical with mulching plus herbicide spraying followed by one hand weeding at 25 DAP.

Weed Biomass

Weed biomass was significantly influenced by different weed management practices (Table 1). The highest weed biomass of 1181 and 1470 g/m² was obtained from weedy check in 2006-07 and 2007-08, respectively. Though, it did not significantly differ from mulch treated plots in 2006-07 but differed significantly (1021 g/m²) in 2007-08. The lowest weed biomass of 212 and 289 g/m² was recorded from mulching plus two hand weedings at 25 and 45 DAP and it was statistically identical with the weed biomass from mulching alongwith application of oxadiazon (0.75 kg/ha) followed by one hand weeding at 25 DAP.

Weed Control Efficiency

The weed control efficiency among the weed management practices ranged from 7.20 to 97.89% in 2006-07 and 16.57 to 98.09% in 2007-08 (Table 1). The highest weed control efficiency was found in weed free plots followed by mulching plus two hand weedings

Table 1. Effect of weed management practices on weed density, weed biomass and weed control efficiency at 90 DAP of potato tuber during 2006-07 and 2007-08

Treatments	Control of weed species over no weeding (%) at 30 DAP		Weed density (No./m ²)		Weed biomass (g/m ²)		Weed control efficiency	
	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08
Weedy check	0	0	18.86 (358)	19.81 (383)	34.27 (1181)	38.36 (1470)	-	-
Mulching with water hyacinth	53	45	17.49 (268)	16.00 (259)	31.80 (989)	32.00 (1021)	07.20	16.57
Mulching+one hand weeding at 25 DAP	59	60	11.00 (121)	12.19 (148)	18.24 (332)	23.99 (566)	46.77	37.46
Mulching+two hand weedings at 25 and 45 DAP	85	84	07.89 (59)	09.00 (77)	14.60 (212)	17.04 (289)	57.39	55.57
Mulching+oxadiazon (0.75 kg/ha) spray at 7 DAP	94	95	10.30 (101)	09.98 (95)	17.00 (278)	18.00 (320)	50.39	53.07
Mulching+oxadiazon (0.75 kg/ha) spray at 7 DAP+ one hand weeding at 25 DAP	100	100	09.93 (97)	09.30 (89)	16.34 (268)	17.80 (317)	52.31	53.59
Weed free	100	100	0.78 (0)	0.72 (0)	0.72 (0)	0.73 (0)	97.89	98.09
LSD (P=0.05)	-	-	1.81	2.53	3.48	2.58		

DAP : Days after planting.

at 25 and 45 DAP (55.57 to 57.39%), mulching plus oxadiazon (0.75 kg/ha) spraying (50.39 to 53.07%). The lowest weed control efficiency (7.20 to 16.57%) was recorded where only mulch was used. Similar results were also observed by Jaiswal and Lal (1996).

Nutrient Uptake by Weeds

The uptake of N, P and K was significantly lower in all the weed control treatments than the weedy check (Table 2). This may be due to luxuriant growth of weeds in weedy check which might have competed strongly with the crop plants for nutrients. Among the weed control treatments, maximum nutrient uptake was recorded with mulching. Amongst the weed control treatments, mulching+oxadiazon (0.75 kg/ha) at 7 DAP + one hand weeding at 25 DAP resulted in significant reduction in N, P and K uptake by weeds than weedy check and other weed control treatments at harvest. However, mulching+oxadiazon (0.75 kg/ha) at 7 DAP proved equally effective in reduction in nutrient uptake by weeds at harvest. These findings confirm those of Prasad and Singh (1995).

Table 2. N, P and K uptake (kg/ha) by weeds and potato as influenced by different treatments at harvest

Treatments	Weeds			Potato		
	N	P	K	N	P	K
Weedy check	51.2	5.80	64.6	17.8	1.63	25.1
Mulching with water hyacinth	32.4	3.50	40.3	27.3	2.47	37.1
Mulching+one hand weeding at 25 DAP	29.4	2.40	36.9	31.7	2.89	43.7
Mulching+two hand weedings at 25 and 45 DAP	11.3	1.26	14.6	61.9	5.72	89.8
Mulching+oxadiazon (0.75 kg/ha) spray at 7 DAP	9.2	1.07	9.2	67.7	6.45	89.7
Mulching+oxadiazon (0.75 kg/ha) spray at 7 DAP+ one hand weeding at 25 DAP	7.2	0.78	9.1	69.0	6.78	94.4
Weed free	-	-	-	73.1	7.04	99.8
LSD (P=0.05)	3.7	0.37	4.7	8.2	0.84	13.0

DAP : Days after planting.

mulching plus oxadiazon (0.75 kg/ha) spraying followed by one hand weeding at 25 DAP produced the maximum yields of 23.43 t/ha in 2006-07 and 29.67 t/ha in 2007-08 and it was statistically identical with mulching plus oxadiazon (0.75 kg/ha) spraying, mulching plus two hand weeding at 25 and 45 DAP, mulching plus one hand weedings at 25 DAP, weed free plots and only mulching treatment. Among the two years, higher tuber yield was recorded in 2007-08. Crop received 50 mm rainfall in 2007-08 during the time of tuber growth that might help in obtaining higher yield than

Nutrient Uptake by Potato Crop

Beneficial effect of weed control treatments in reducing the nutrient drain by weeds was reflected in significantly increased uptake of N, P and K by crop than that under the weedy check. The weed control treatments resulted in more uptake of nutrients by the crop which ultimately resulted in higher tuber yield. Under the weedy check condition crop could utilize minimum nutrients (17.8, 1.63 and 25.1 kg N, P and K/ha, respectively), whereas under mulching + oxadiazon (0.75 kg/ha) at 7 DAP + one hand weeding at 25 DAP, it utilized 69.0, 6.78 and 94.4 kg/ha N, P and K than that of weedy check. Maximum N, P and K uptake of potato was observed in weed free plots which differed significantly to weedy check (Table 2).

Tuber Yield

Tuber yield of potato was significantly influenced due to different weed management practices (Table 3). Weedy check treatment gave the lowest tuber yield of 13.81 t/ha in 2006-07 and 13.38 t/ha in 2007-08. The treatment

2006-07. Averaged over the years, weed infestation resulted in 43% reduction in tuber yield. Similar results were also reported by Jaiswal and Lal (1996). Though weed free treatment showed 98.09% weed control efficiency but yielded lower than mulching plus two hand weedings at 25 and 45 DAP, mulching plus oxadiazon (0.75 kg/ha) spraying and mulching plus oxadiazon (0.75 kg/ha) spraying followed by one hand weeding at 25 DAP. Water hyacinth might help conserve soil moisture (Wofford and Orzolek, 1993) and served as an effective barrier to weed emergence.

Table 3. Yield, cost and benefit analysis of potato as affected by different weed management practices during 2006-07 and 2007-08

Treatments	Tuber yield (t/ha)		Gross return (Rs./ha)		Total cost (Rs./ha)		Net return (Rs./ha)		B : C ratio	
	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08
	Weedy check	13.81	13.38	69050	79798	38140	48333	30910	31465	1.81
Mulching with water hyacinth	21.15	24.45	105750	145819	41339	51685	64411	94134	2.55	2.82
Mulching+one hand weeding at 25 DAP	22.36	28.00	111800	166992	42347	53634	69453	113358	2.64	3.10
Mulching+two hand weeding at 25 and 45 DAP	22.90	28.65	114500	170868	43019	54776	71481	116092	2.66	3.12
Mulching+oxadiazon (0.75 kg/ha) spray at 7 DAP	23.00	28.14	115000	167826	42083	52479	72917	115347	2.73	3.19
Mulching+oxadiazon (0.75 kg/ha) spray at 7 DAP+ one hand weeding at 25 DAP	23.43	29.67	117150	176951	42587	54092	74563	122859	2.75	3.27
Weed free	22.58	25.32	112600	151008	41164	53172	71436	97836	2.73	2.83
LSD (P=0.05)	2.33	5.31	-	-	-	-	-	-	-	-

DAP : Days after planting.

Economics

Economic analysis of different weed management practices on potato production was done (Table 3). Maximum gross return of Rs. 117150 and 176951/ha was obtained from mulching with application of oxadiazon (0.75 kg/ha) followed by one hand weeding at 25 DAP in both the years, and it was slightly higher than mulching plus oxadiazon (0.75 kg/ha) at 7 DAP in 2006-07. Similar trend was followed in case of net return. Higher cost was also recorded in treatment mulching plus two hand weedings at 25 and 45 DAP in both the years. The cost of cultivation was much higher in 2007-08 than in 2006-07 due to higher labour wages. The maximum benefit : cost ratios of 2.75 in 2006-07 and 3.27 in 2007-08 were obtained from mulching and oxadiazon (0.75 kg/ha) spraying plus one hand weeding at 25 DAP and this was followed by mulching plus oxadiazon (0.75 kg/ha) spraying at 7 DAP.

Based on two years' findings, mulching (water hyacinth) with oxadiazon (0.75 kg/ha) at 7 DAP as post-emergence weed control followed by one hand weeding at 25 DAP would be economically profitable for obtaining maximum tuber yield of potato in Hassan district of Karnataka.

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