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Effect of Weed Management Practices on Weed Density, Weed Control Efficiency, Weed Index and Yield of Potato (*Solanum tuberosum* L.)

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A B S T R A C T

A field experiment was conducted during *kharif* 2016 at College of Agriculture, Hassan, University of Agricultural Sciences, Bengaluru to evaluate different pre and post emergent herbicides on growth and yield of potato (*Solanum tuberosum* L.) the soil of experimental site is red sandy loam in texture, neutral in reaction and medium in available nitrogen, phosphorus and potassium. The experiment was laid out in a RCBD with seven treatments replicated thrice. The investigation revealed that, among different herbicides, lower sedge density and dry weight was recorded by Metribuzin 500 g a.i. ha^{-1} as pre-emergent (20.5 m^{-2} and 9.0 g m^{-2}, respectively). Whereas application of Fenoxaprop–p-ethyl 54 gm a.i. ha^{-1} as early post emergent at 20 DAP recorded significantly lower grasses, broad leaved and total weed density (15.3, 24.7 and 62.0 m^{-2}, respectively), weed dry weight (7.9, 10.3 and 28.1 g m^{-2}, respectively), lower weed index (5.9 %), higher weed control efficiency (73.3 %). This treatment registered significantly higher tuber yield (19.77 t ha^{-1}) which was on par with Quizalofop–p-ethyl (18.93 t ha^{-1}) and significantly lower tuber yield was recorded in weedy check (14.00 t ha^{-1}).

Introduction

Potato (*Solanum tuberosum* L.) is one of the most important vegetable cum food crops of the world. Potato is cultivated in 2.13 m ha^{-1} in India, with a production of 43.7 m t and productivity of 20.5 MT ha^{-1} (Anon., 2016). Potato is a short duration crop; therefore, it fits in well for rotation with cereals, vegetables, pulses, or oilseed crops. At present, potato is grown in about 15 countries of the world on a wide range of soils and agro climatic conditions (Khuranka and Naik, 2003). In Karnataka it is grown as rainfed crop in Hassan, Belgaum, Dharwad and Chikkamagaluru districts during *Kharif* (June to September) and as an irrigated crop during *rabi* (November to February) in the districts of Kolar, Chikkaballapura and Bengaluru rural. Hassan and Chikkamagaluru are the major potato producing districts under southern transitional zone of Karnataka contributing nearly 60 per cent of the total production in the state (Anon., 2013). There are several constraints in potato production, of which weeds often pose a serious problem. It is a very poor competitor with weeds because of its extremely slow growth in the initial emergence phase. The yield reduction due to weeds in potato is estimated to be as high as

10 to 80 per cent (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. Timely weed control may not be possible manually due to non-availability of labours and high rate of wages during peak period of farm operations. Hence, chemical weed control appears to hold a great promise in dealing with effective, timely and economic weed suppression.

Materials and Methods

A field experiment was conducted during *kharif* 2016 at College of Agriculture, Hassan, University of Agricultural Sciences, Bengaluru. The experimental site is geographically situated in the Southern Transitional Zone (Zone - 7) of Karnataka and located between 12º 13' and 13º 33' N Latitude and 75º 33' and 76º 38' E Longitude at an altitude of 827 m above Mean Sea Level (MSL). The soil of the experimental site was red sandy loam. The experiment was laid out in randomized block design with seven treatments and replicated thrice. The treatments comprised of four herbicide levels, conventional weed control practices followed by the farmers and check treatments *Viz*., weedy check and weed free check. The data was statistically analyzed by following the method of Gomez and Gomez (1984). The observations on weed growth like weed density and weed dry weight were recorded at 30, 60 DAP and at harvest. Data on weed count and weed dry weight showed high variation. To make the analysis of variance more valid the data on weed count and weed dry weight was subjected to square root transformation by using formula $\sqrt{x + 0.5}$ (Chandel, 1984). Critical difference for the significant source of variation was calculated at five per cent level of significance. Treatment differences those were not significant were denoted by NS.

Weed observations

Weed count (No. m^{-2})

In each treatment a quadrant of 0.5 m x 0.5 m was earmarked in the net plot for recording weed count. From the quadrant weeds were removed and number of sedges, grasses and broad leaf weeds were counted and recorded. Later the original values were transformed to square root transformation ($\sqrt{X+0.5}$) and subjected to statistical analysis.

Weed dry weight (g m^{-2})

The weeds present within the quadrant area were uprooted, and transferred to brown covers. After air drying again weeds were dried in the hot air oven at 65-70^0 C till the constant weights obtained.

Weed control efficiency (%)

Weed control efficiency was calculated on dry weight basis by adopting the formula given by Mani *et al.,* (1976)

$$WCE\ (\%) = \frac{DWC - DWT}{DWC} \times 100$$

Where,

WCE = Weed control efficiency (%)

DWC = Dry weight of weeds in weedy check plot (g m^{-2})

DWT = Dry weight of weeds in treated plot (g m^{-2})

Weed index (%)

It is an index expressing the reduction in yield due to presence of weeds in comparison with weed free situation. It was expressed in per cent and calculated by using the formula given below

$$\text{WI (\%)} = \frac{\text{Maximum tuber yield} - \text{Tuber yield in a treatment}}{\text{Maximum tuber yield}} \times 100$$

Results and Discussion

Effect of weed management practices on weed growth

The major weed flora observed in the experimental fields were *Cyperus rotundus* (among sedge), *Cynodon dactylon, Digitaria marginata* (among grasses); while among broad leaf weeds *Commelina benghalensis, Ameranthus viridis, Chinapodium album* (initial 30 DAP). Other weeds noticed in lower densities were *Cleome viscose, Fumaria purviflora* (initial 30 DAP), *Euphorbia hirta* (initial 60 DAP). Weed management practices significantly influenced the sedge, grass, broad leaf weeds and total weed density at harvest (Table 1). Among the different herbicides, sedge density and dry weight was significantly lower in T_2 *i.e.,* Metribuzin 500 g a.i. ha^{-1} as pre-emergent application (20.5 m^{-2} and 9.0 g m^{-2}, respectively) and it was found on par with T_1 *i.e.,* Farmers practice (Intercultivation at 20 DAP and earthing up at 30 DAP) (21.0 m^{-2} and 9.0 g m^{-2}, respectively). However, significantly higher sedge density and dry weight was found in T_6 *i.e.,* Weedy check (42.0 m^{-2} and 30.3 g m^{-2}, respectively). So pre-emergent application owing to better herbicide action in controlling the weed density and dry weight of weeds due to inhibiting the enzyme activity and caused the disruption of protein synthesis and other subsequent bio-chemical reactions which in turn inhibited the weed growth and lower density and dry weight of sedges. The results are in conformity with the findings of Bedmar (1997); Abdullahi *et al.,* (2000).

Among the different herbicides application of Fenoxaprop–p-ethyl 54 gm a.i. ha^{-1} as early post emergent recorded significantly lower grasses, broad leaved and total weed density (15.3, 24.7 and 62.0 m^{-2}, respectively), lower weed dry weight (7.9, 10.3 and 28.1 g m^{-2}, respectively) and it was found on par with T_4 *i.e.,* Quizalofop–p-ethyl 30 g a.i. ha^{-1} as early post emergent. Significantly higher grasses, broad leaved and total weed density (46.3, 60.2 and 149 m^{-2}, respectively), weed dry weight (33.0, 42.0 and 105.3 g m^{-2}, respectively) were recorded in weedy check. The lower density and dry weight of weeds was due to the competitive inhibition of the acetyl coenzyme A carboxylase (ACCase) enzyme in susceptible grass plants there by blocking lipid biosynthesis. The results are in conformity with the findings of Bedmar (1997); Abdullahi *et al.,* (2000).

Effect of weed management practices on weed control efficiency

Weed control efficiency is a measure of the efficiency of weed control methods in restricting the weed growth. The crop yield is directly proportional to weed control efficiency (WCE) and inversely related to weed index (WI). At 60 DAP, application of Fenoxaprop–p-ethyl 54 g a.i. ha^{-1} as early post emergent recorded higher weed control efficiency (76.8 %).

This was due to better control of weeds during crop growth period which lowered the total weed population and its dry weight (Table 2, Fig. 1). At harvest, application of Fenoxaprop–p-ethyl 54 g a.i. ha^{-1} as early post emergent registered higher weed control efficiency (73.3 %) may be due to significant reduction in the weed dry weight as a result of broad spectrum weed control and elimination of competition from weeds during critical period of crop weed competition. These results are in accordance with Sitangshu (2006).

Table.1 Category wise weed density (number m^{-2}) and category wise weed dry weight (g m^{-2}) at harvest in potato as influenced by weed management practices

Treatments		Density of weeds				Dry weight of weeds			
		Sedges*	Grasses*	BLW*	Total*	Sedges**	Grasses**	BLW**	Total**
T_1	Farmers practice	1.3(21.0)	1.4(26.0)	1.5(33.3)	1.9(80.3)	2.6(9.5)	3.6(12.0)	4.0(14.9)	5.7(36.4)
T_2	Metribuzin 500 g a.i. ha^{-1} as PE	1.3(20.5)	1.4(21.3)	1.5(30.0)	1.9(71.8)	2.5(9.0)	3.4(10.3)	3.7(12.9)	5.3(32.2)
T_3	Fenoxaprop –p-ethyl 54 g a.i. ha^{-1} as EPE	1.4(22.0)	1.2(15.3)	1.4(24.7)	1.8(62.0)	3.3(9.9)	2.42(7.9)	2.9(10.3)	4.2(28.1)
T_4	Quizalofop –p-ethyl 30 g a.i. ha^{-1} as EPE	1.4(23.7)	1.3(18.7)	1.5(29.0)	1.8(71.4)	3.4(10.6)	2.7(8.9)	3.1(11.5)	4.4(31.0)
T_5	Paraquat dichloride 480 g a.i. ha^{-1} as EPE	1.4(24.7)	1.4(23.3)	1.5(32.0)	1.9(80.0)	3.6(11.3)	3.5(11.0)	3.8(13.5)	5.5(35.8)
T_6	Weedy check	1.6(42.0)	1.7(46.3)	1.8(60.7)	2.2(149)	5.6(30.3)	5.8(33.0)	6.5(42.0)	10.3(105.3)
T_7	Weed free check	0.30(0.0)	0.30(0.0)	0.30(0.0)	0.30(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.00)
S.Em±		0.03	0.03	0.04	0.03	0.08	0.12	0.10	0.55
LSD(p=0.05)		0.09	0.10	0.12	0.08	0.26	0.36	0.30	1.68

Data within parentheses are original values; * - data analyzed using log (x+2) transformation, ** - square root (x+1) transformation;
Note: PE: pre-emergent application EPE: early post emergent application BLW: Broad leaf weeds DAP-days after planting

Table.2 Weed control efficiency (WCE %) and weed index (WI %) at different growth stages of the crop as influenced by weed management practices

Treatments		WCE %			WI (%)
		30 DAP	60 DAP	At harvest	
T_1	Farmers practice	74.9	67.7	65.5	23.0
T_2	Metribuzin 500 g a.i. ha^{-1} as PE	77.8	74.8	69.4	13.8
T_3	Fenoxaprop –p-ethyl 54 g a.i. ha^{-1} as EPE	79.5	76.8	73.3	5.9
T_4	Quizalofop –p-ethyl 30 g a.i. ha^{-1} as EPE	77.9	75.0	70.6	9.8
T_5	Paraquat dichloride 480 g a.i. ha^{-1} as EPE	73.8	70.1	66.0	17.0
T_6	Weedy check	0.0	0.0	0.0	33.3
T_7	Weed free check	100.0	100.0	100.0	0.0

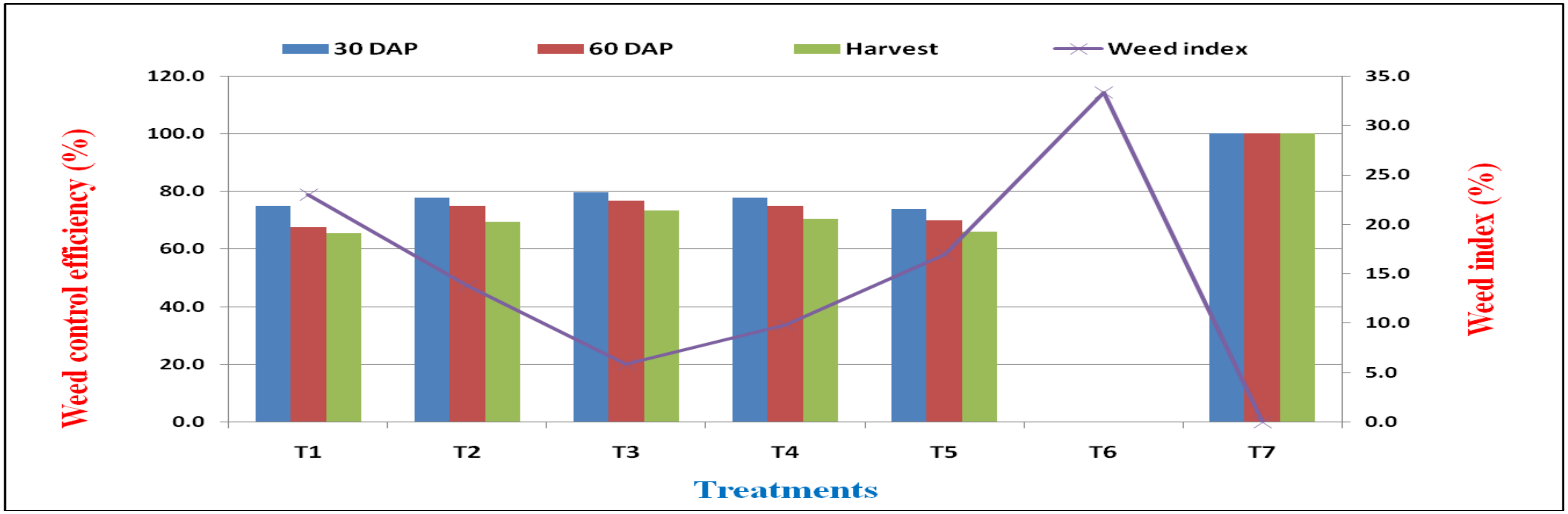
Note: PE: pre-emergent application EPE: early post emergent application BLW: Broad leaf weeds DAP-days after planting

Table.3 Effect of different weed management practices on yield and yield attributes

Treatments		Tuber weight plant^{-1}(g)	Number of tubers plant^{-1}	Tuber yield (t ha^{-1})
T_1	Farmers practice	235.67	2.50	16.17
T_2	Metribuzin 500 g a.i. ha^{-1} as PE	242.67	3.43	18.10
T_3	Fenoxaprop –p-ethyl 54 g a.i. ha^{-1} as EPE	250.50	4.30	19.77
T_4	Quizalofop –p-ethyl 30 g a.i. ha^{-1} as EPE	247.67	4.07	18.93
T_5	Paraquat dichloride 480 g a.i. ha^{-1} as EPE	238.67	3.00	17.43
T_6	Weedy check	221.67	2.10	14.00
T_7	Weed free check	253.33	4.50	21.00
S.Em±		3.57	0.14	0.79
LSD(p=0.05)		10.99	0.44	2.2

Note: PE: pre-emergent application EPE: early post emergent application BLW: Broad leaf weeds DAP-days after planting

Fig.1 Weed control efficiency (%) and weed index (%) at different growth stages in potato as influenced by weed management practices



Effect of weed management practices on weed index

Weed index is a measure of reduction in the tuber yield due to competition stress offered by weeds as against weed free treatment. The weed competition was higher in weedy check (33.3 %). This was due to less potato tuber yield associated with unchecked weed growth throughout the crop growth period (Table 2, Fig. 1). However, lower weed index (5.9 to 17.1 %) was noticed in application of Fenoxaprop–p-ethyl 54 g a.i. ha^{-1}, Quizalofop–p-ethyl 30 g a.i. ha^{-1}, Metribuzin 500 g a.i. ha^{-1} and Paraquat dichloride 480 g a.i. ha^{-1}, as a result of satisfactory control of weeds owing to reduction in the crop weed competition. The effective use of herbicides at optimum dosage and time of application might have enabled the crop to utilize available resources like light, nutrients, moisture and space to a greater extent resulting in higher yield.

Effect of different weed management practices on yield and yield attributes

Application of Fenoxaprop–p-ethyl 54 g a.i. ha^{-1} as early post emergent recorded significantly higher tuber weight (250.50 g), number of tubers (4.30) and tuber yield (19.77 t ha^{-1}). Higher tuber yield was attributed to better control of weeds, lower weed index and higher weed control efficiency throughout the crop growth period, which resulted in better availability of growth factors like light, space, nutrients and moisture to the potato crop resulting in better crop growth and yield. These findings are in confirmatory with the work of Chitsaz and Nelson (1983) Table 3.

The study concluded that higher weed control efficiency (73.3 %), lower weed index (5.9 %), higher number of tubers (4.30) and tuber yield (19.77 t ha^{-1}) at harvest were recorded by application of Fenoxaprop–p-ethyl 54 g a.i. ha^{-1} as early post emergent as compared to the weedy check except weed free check.

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