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Effect of Different Weeding Methods on Correlation Studies and Phytotoxicity Symptoms on Potato (*Solanum tuberosum* L.)

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Authors' contributions

This work was carried out in collaboration between all authors. Author RH designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors RJ and GP managed the analyses of the study. Authors RH and RJ managed the literature analyses of the study. All authors read and approved the final manuscript.

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ABSTRACT

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 higher yield was obtained in weed free check, while among the herbicide treatments fenoxaprop–p-ethyl 54 g a.i. ha^{-1} as early post emergent recorded between components such as number of tubers per plant (r= 0.977*), and tuber weight per plant (r= 0.977*) with tuber yield. The correlation between growth and yield attributes of potato was positively correlated while significant negative correlation between yield and weed density and dry weight.

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1. INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the most important vegetable cum food crops of the world. It belongs to family Solanaceae and genus Solanum, and native of the Andean plateau of South America. It has the capacity to produce more energy and protein per unit area per unit time. Potato protein is superior to that of cereals and rich in essential amino acid lysine and vitamin C. Hence, potato is one of the richest sources of calories needed to maintain day to day output of human energy.

Hand weeding and hoeing are common practices followed in India. However, 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. Presence of weeds throughout the growing period of the crop caused 62 per cent reduction in tuber yield. However, the weeds prevalent in and around the crop hamper potato cultivation thereby resulting in substantial reduction in yield [1]. Manual weeding is quite effective but costly, tedious, time consuming and also causes root injury [2].

Use of suitable herbicides alone or in combination with manual or mechanical weeding for weed control reduce the cost towards weed control by 75-85 per cent compared to manual weeding [3]. In Hassan district of Karnataka, scarcity of labourers is found during crop season and the labour charges are also very high which increases the cost of production. In this situation, farmers of Hassan district need suitable technology for weed management. Hence, the present study is undertaken to find out an effective and economical weed control method for increasing productivity of potato.

Advantages of chemical weed control lie in its superior efficiency, economy and easiness. Chemicals like pendimethalin and alachlor as pre-emergence and paraquat as early post emergence have been used for weed control in potato. But weeds generally emerge during later stage of crop growth even after application of aforesaid weedicides.

2. 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 12º13' and 13º33' N Latitude and 75º33' and 76º38' E Longitude at an altitude of 827 m above Mean Sea Level (MSL). The experiment was laid out in randomized block design with seven treatments and replicated thrice.

2.1 Soil and its Characters

The soil of the experimental site was red sandy loam. The initial soil sample was drawn from the experimental site. Sample was air dried, powdered, sieved and stored in polythene cover for further physical and chemical analysis. The results of the soil analysis along with the methods followed are presented in Table 2.

2.2 Treatment Details

No. of treatments : 7
No. of replications : 3
Design : RCBD

T_1: Farmers practice (Intercultivation at 20 DAP and earthing up at 30 DAP)

T_2: Metribuzin 500 g a.i. ha^{-1} as pre-emergent application

T_3: Fenoxaprop–p-ethyl 54 g a.i. ha^{-1} as early post emergent application

T_4: Quizalofop–p-ethyl 30 g a.i. ha^{-1} as early post emergent application

T_5: Paraquat dichloride 480 g a.i.ha^{-1} as early post emergent application

T_6: Weedy check

T_7: Weed free check

Note: **DAP:** days after planting, earthing up is common at 30 DAP
Spray volume: 750 l ha^{-1} for pre-emergent and 500 l ha^{-1} for post-emergent herbicides

2.3 Varietal Description of Kufri Jyothi

Tubers are large oval flattened with white skin eyes fleet and flesh is dull white in colour. A widely adaptable fertilizer responsive variety possessing high degree of field resistance to late blight disease in the foliage and also a good degree of tuber resistance to the same disease. This is also resistant to the wart and moderately resistant to cercospora leaf spot. It is being recommended in various states in India including Karnataka for commercial cultivation.

It matures in 110-120 days in the hills and it takes 100 days to mature in plains. It yields 180-200 q ha^{-1} in the hills. In plains including Karnataka Kufri Jyothi yields 150-200 q ha^{-1}under irrigated conditions and 75-100 q ha^{-1}under rainfed conditions.

2.4 Fertilizer Application and Planting

After bringing the soil to fine tilth, furrows at 60 cm apart were formed and calculated quantities of recommended dose of 75 N + 75 P_2O_5 + 100 K_2O kg ha^{-1} were applied in the form of urea, di ammonium phosphate and muriate of potash, respectively as per the treatments to each plot and mixed well into the soil. The tubers were planted half way the ridge at a distance of 20 cm. Fifty per cent of the recommended nitrogen was applied at the time of planting and remaining fifty percent was applied four weeks after planting as top dressing.

2.5 Plant Protection

The crop was first sprayed with a mixture of Dithane-M-45 at 2 g per litre of water to control late blight as a prophylactic measure. Ridomil at 2 g per litre of water was used for subsequent sprays along with confidor at 0.5 ml per litre of water.

2.6 Imposition of Treatments

The required quantities of herbicides were applied as pre emergence (2 days after planting) and early post emergence (20 DAP) as per the treatments. The conventional weed control practices followed by the farmers and check treatments *Viz*., weedy check and weed free check. Pre-emergent application of Metribuzin 500 g a.i. $ha^{-1}$was imposed on 17/06/2016. Early post emergent application of Fenoxaprop–p-ethyl 54 g a.i. ha^{-1}, Quizalofop–p-ethyl 30 g a.i. ha^{-1}, Paraquat dichloride 480 g a.i. $ha^{-1}$was imposed on 05/07/2016.

2.7 Weed Observations

2.7.1 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.

2.7.2 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 65-70ºC till the constant weights obtained.

2.7.3 Weed control efficiency (%)

Weed control efficiency was calculated on dry weight basis by adopting the formula given by [4].

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

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 (gm^{-2})

2.7.4 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

WI (%) = Maximum tuber yield – Tuber yield in a treatmentMaximum Tuber yield ×100

2.8 Phytotoxicity Rating on Crop

Visual observations were recorded on 15, 25 and 35 days after spraying of herbicides to know the extent of toxicity caused by herbicides on crop by using phytotoxicity rating zero (no toxicity) to 10 (100 % toxicity) scale. The phytotoxicity rating (using 0 to 10 scale) was recorded on symptoms -epinasty, hyponasty, necrosis symptoms, wilting, vein clearing and stunted growth (Table 1).

2.9 Statistical Analysis and Interpretation of Data

The data was statistically analyzed by following the method of [6]. The observations on weed growth like weed density and weed dry weight were recorded at 30, 60 DAP and at harvest. The data on weed count and weed dry weight was subjected to square root transformation by using formula $\sqrt{x} + 0.5$ [7]. 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.

3. RESULTS AND DISCUSSION

3.1 Effect of Weed Management Practices on Correlation Studies

The correlation coefficient values (r) were worked out for tuber yield versus various growth and yield parameters and the values are presented in (Tables 3 & 4). Tuber yield had positive significant correlation with total dry matter production per plant at harvest, number of shoots at harvest, yield attributes like tuber weight, number of tubers per plant. The number of leaves per plant showed relatively

Table 1. The crop phytotoxicity rating using 0 to 10 point scale [5]

Effect	Score	Phytotoxicity symptoms
None	0	No injury, normal
	1	Slight stunting injury or discoloration
Slight	2	Some stand loss, stunting or discoloration
	3	Injury more pronounced but not persistent
Moderate	4	Moderate injury, recovery possible
	5	Injury more persistent, recovery possible
	6	Near severe injury, no recovery possible
Severe	7	Severe injury, stand loss
	8	Almost destroyed, a few plants surviving
	9	Very few plants alive
Complete	10	Complete destruction

Table 2. Physico-chemical properties of soil in the experimental site

Particulars	Values	Status	Method followed
I. Physical properties			
1.Sand	65.8%	-	International pipette method [8]
2.Silt	7.4%	-	
3.Clay	25.8%	-	
4.Soil textural class	Red sandy loam		
II. Chemical properties			
1. pH (1:2.5)	7.08	Neutral	Potentiometric method [9]
2. EC (1:2.5) (dSm^{-1})	0.22	Low	Conductometric method [9]
3. Organic carbon (%)	0.48	Low	Wet oxidation method [10]
4. Available N (kg ha^{-1})	334.3	Medium	Alkaline potassium permanganate method [11]
5. Available P_2O_5 (kg ha^{-1})	54.8	High	Bray's extract [9]
6. Available K_2O (kg ha^{-1})	223.0	Medium	Flame photometry [9]

higher positive correlation with tuber yield compared to other parameters. Tuber yield of potato had negative significant correlation with total weed density and dry weight at 30, 60 DAP and at harvest. This was mainly attributed to positive relation between components such as number of tubers per plant (r= 0.977*), and tuber weight per plant (r= 0.977*) with tuber yield. The reason for increased yield components might be due to efficient control of weeds during crop growth period which reduced crop weed competition for nutrients, light, moisture and space and provided better environment for crop growth and development and less phytotoxocity to crop resulted in increased availability of plant nutrients and moisture to crop throughout the growth period this lead to more initiation of stolons. The favourable condition created by efficient weed management resulted in competition free environment. This has increased the capacity of source and sink which in turn increased the number of tubers per plant and tuber weight. This result is confirmation with [12].

3.2 Effect of Weed Management Practices on Visual Phytotoxicity Symptoms

The herbicides used in the present investigation did not cause any phytotoxicity in terms of epinasty, hyponasty and wilting of potato crop at 15, 25 and 35 days after spraying of herbicide (Tables 5 & 6). Slight necrotic and stunted growth with visual phytotoxicity score of 1 was noticed at 15, 25 and 35 days after spraying of herbicides in case of metribuzin and paraquat dichloride herbicides. But these symptoms disappeared at a later stage and potato crop looked healthy with good growth and development (Plate 1). These findings are in confirmatory with the work of [13,14,15,16].

Table 3. Correlation for growth and yield attributes of potato as influenced by weed management practices

Plant growth and yield attributes	Tuber yield
Plant height at harvest (cm)	0.977*
Number of shoots at harvest (plant^{-1})	0.989*
Number of leaves at harvest (plant^{-1})	0.994*
Leaf area at harvest (cm^2)	0.987*
Total dry matter at harvest (plant^{-1})	0.980*
Number of tubers (plant^{-1})	0.977*
Tuber weight (g plant^{-1})	0.977*
Tuber yield (t ha^{-1})	0.992*

** Significant at 5 % level; DAP- days after planting*

Table 4. Correlation between weed growth and tuber yield of potato as influenced by weed management practices

Weed Growth and yield attributes	Tuber yield
Total weed density at 30 DAP (No. m^{-2})	-0.903*
Total weed density at 60 DAP (No. m^{-2})	-0.903*
Total weed density at harvest (No. m^{-2})	-0.899*
Total weed dry weight at 30 DAP (g m^{-2})	-0.824*
Total weed dry weight at 60 DAP (g m^{-2})	-0.882*
Total weed dry weight at harvest (g m^{-2})	-0.893*
Weed control efficiency at harvest (%)	0.893*
Weed index (%)	-0.999*

** Significant at 5 % level; DAP-Days after planting*

Table 5. Visual phytotoxicity symptoms score of herbicides on potato crop at different days after application

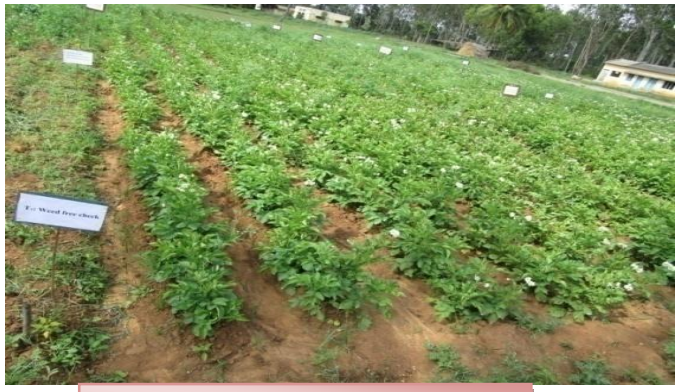
Treatments		Phytotoxicity symptoms - days after application of herbicides								
		Epinasty			Hyponasty			Necrotic		
		15	25	35	15	25	35	15	25	35
T_1	Farmers practice	0	0	0	0	0	0	0	0	0
T_2	Metribuzin 500 g a.i. ha^{-1} as PE	0	0	0	0	0	0	**1**	0	0
T_3	Fenoxaprop –p-ethyl 54 g a.i. ha^{-1} as EPE	0	0	0	0	0	0	0	0	0
T_4	Quizalofop –p-ethyl 30 g a.i. ha^{-1} as EPE	0	0	0	0	0	0	0	0	0
T_5	Paraquat dichloride 480 g a.i. ha^{-1} as EPE	0	0	0	0	0	0	0	0	**1**
T_6	Weedy check	0	0	0	0	0	0	0	0	0
T_7	Weed free check	0	0	0	0	0	0	0	0	0

Note: Farmers practice (Intercultivation at 20 DAP and earthing up at 30 DAP) ***PE:*** *pre-emergent application*
EPE: *early post emergent application*

Table 6. Visual phytotoxicity symptoms score of herbicides on potato crop at different days after application

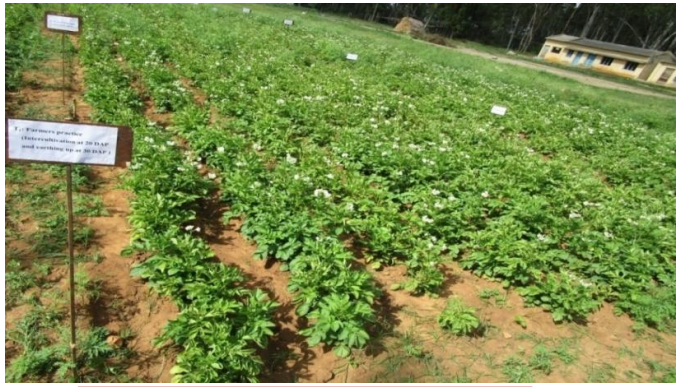
Treatments		Phytotoxicity symptoms - days after application of herbicides					
		Stunted growth			Wilting		
		15	25	35	15	25	35
T_1	Farmers practice	0	0	0	0	0	0
T_2	Metribuzin 500 g a.i. ha^{-1} as PE	0	0	1	0	0	0
T_3	Fenoxaprop –p-ethyl 54 g a.i. ha^{-1} as EPE	0	0	0	0	0	0
T_4	Quizalofop –p-ethyl 30 g a.i. ha^{-1} as EPE	0	0	0	0	0	0
T_5	Paraquat dichloride 480 g a.i. ha^{-1} as EPE	0	0	1	0	0	0
T_6	Weedy check	0	0	0	0	0	0
T_7	Weed free check	0	0	0	0	0	0

Note: Farmers practice (Intercultivation at 20 DAP and earthing up at 30 DAP) ***PE:*** *pre-emergent application*
EPE: *early post emergent application*



T_7: Weed free check

T_7: Weed free check



T_1: Farmers practice

T_6: Weedy check

Plate1. Performance of potato under different treatment at 60 DAP

4. CONCLUSION

The study concluded that application of early post emergent herbicides like Fenoxaprop–p-ethyl 54 g a.i. ha^{-1} resulted in profitable potato cultivation. Slight necrotic and stunted growth with visual phytotoxicity score of 1 was noticed at 15, 25 and 35 days after spraying of herbicides in case of metribuzin and paraquat dichloride herbicides. But these symptoms disappeared at a later stage and potato crop looked healthy with good growth and development

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Singh BN. Efficacy of herbicides for weed control and nitrogen fertilization in potato. Indian J. Weed. Sci. 1984;16(1):29-35.
2. Khurana SC, Thakral KK, Bhatia KK. Effect of pendimethalin and isoproturon on weeds and tuber yield of potato. Indian Potato Assoc. 1993;20:255-257.
3. Gopinath KA, Mina BL. Use of herbicides in integrated weed management in field crops of Uttarakhand hills. Ind. Far. 2009; 59:14-17.
4. Mani VS. Chakraborty TK, Gautam KC. Double hedge weed killers in peas. Indian Fmg. 1976;26(2):80-83.
5. Anonymous. Manual for field trials in plant protection. CIBA GIEGY Ltd., Switzerland. 1981;57-60.
6. Gomez KA, Gomez AA. Statistical procedures for agricultural research. IRRI, Willey-Inter Science pub., New York, USA. 1984;680.
7. Chandel SRS. Analysis of variance. A Hand Book of Agricultural Statistics. 7th Edition. 1984;358-359.
8. Piper CS. Soil and plant analysis. Inter Sci. Pub., Inc. New York; 1966.
9. Jackson. ML. Soil Chemical Analysis, Prentice Hall of India, Pvt. Ltd. New Delhi. 1973;498.
10. Walkley A. Black CA. An examination of Degtareff method for determining soil organic matter and proposed modification of chromic and titration method. Soil Sci. 1934;37:29-38.
11. Subbiah BV, Asija GL. A rapid procedure for the estimation of available nitrogen in soils. Current, Sci. 1956;25(8):259-260.
12. Chitsaz M, Nelson DC. Comparison of various weed control programes for potatoes. American potato J. 1983;60: 336-339.
13. Robinson DK, David WM, Monaco TJ. Potato (*Solanum tuberosum* L.) tolerance and susceptibility of eight weeds to rimsulfuron with and without metribuzin. Weed Sci. Soc. of America and Allen Press. 1996;10:29-34.
14. John AA, Henry PW, Thomas EH. Weed management programs in potato (*Solanum tuberosum*) with rimsulfuron. Weed Tech. 1996;10:354-358.
15. Bellinder RR, Kirkwyland JJ, Wallace RW. Carrot (*Daucuscarota*) and weed response to linuron and metribuzin applied at different crop stages. Weed Tech. 1997; 11(2):235-240.
16. Henry PW, David WM, Thomas EH, Robert JM. Responses of potato (*Solanum tuberosum*), tomato (*Lycopersicon esculentum*) and several weeds to ASC-67040 herbicide. Weed Tech. 2001;15: 271-276.

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