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Effect of various Weed Control Measures on Growth and Yield of Potato (*Solanum tuberosum* L.) in Grid Region

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ABSTRACT: The field experiment was conducted to study the effect of various weed control measures on growth and yield of potato in grid region at the Directorate of Weed Science Research (DWSR) Centre, College of Agriculture, (RVSKVV) Gwalior (M.P.) during the *rabi* season of 2016-2017. Crop growth parameters, *viz*., plant population (7.94), plant height (26.73, 41.27 and 42.40 cm), number of compound leaves (26.27, 48.27 and 51.96) and number of stem (4.53, 5.25 and 6.18), fresh (60.40, 222.40 and 306.61g) and dry weight of plant (8.14, 40.88 and 65.28 g), fresh weight of haulm /plant (53.73, 97.07 and 108.61 g) and Dry weight of haulm /plant (6.88, 15.34 and 21.72 g) were recorded at 30, 60 and harvest stage respectively. Yield attributes and yield parameters, *viz*., Number of tubers plant^{-1} (4.47, 5.58 and 5.91 g), Fresh (6.67, 125.33 and 198 g) and dry weight (1.27, 25.54 and 43.56 g) and tuber yield ha^{-1} (145.83 q) and Biological yield (231.51 q/ha), haulm yield (85.68 q/ha) and harvest index (63.40 %) were significantly influenced at 60 DAP and maturity respectively by the different weed control treatments. Resulting in production of higher crop growth parameters, yield attributes and yield than other organic weed control treatments T_6 and was found highly effective for attaining higher weed suppression and yield simultaneously and superior over rest of the organic weed control treatments.

Keywords: Weed flora, control methods, organic control and potato etc.

INTRODUCTION

The potato (*Solanum tuberosum* L.) is an annual herbaceous tuber crop of the Solanaceae family that contains all the essential food ingredients required for maintaining proper human health. Potato is the staple food of almost half of the world's population. Potato is the fourth most important food crop in the world, after corn, rice, and wheat. It is known as a protective food because potato protein is rich in lysine, which is one of the most important amino acid. It is also the most important food crop in the world, and it contains approximately 78% water, 22% dry matter, 20.6% carbohydrates, 2.1% protein, 1.1% crude fiber, 0.9% ash, and 0.3% fat. In India, about 68% of potatoes are utilized for table purposes, 7.5% for processing, 8.5% for seed, and the remaining 16% of produce goes waste during pre- and post-harvest handling (Gupta *et al*., 2014).

It is used for variety of purposes and typically used as a vegetable as a result regarded as "King of vegetable". But in fact, it is likely that less than 50 per cent of potato grown worldwide is consumed fresh in the form of vegetable. The rest are processed into potato food product (potato flour, chips, French fries etc.) and food ingredients, food to cattle, pigs and chickens and processed into starch for industry.

In India, it is grown on an area of 2.14 million hectares with a production of 51.31 million tonnes and a productivity of 24.0 tonnes ha^{-1} (Agriculture Statistics at a Glance, 2021). Currently, Madhya Pradesh contributes about 6.96 percent of area and 6.58 percent of production of potatoes in the country. Its productivity in Madhya Pradesh is 22762 kg ha $^{-1}$ (Agriculture statistics at a glance, 2021).

In Potato weed control plays a crucial role in influencing the growth and yield of potato crops. Effective weed management not only minimizes competition for essential resources but also mitigates potential negative impacts on potato plants. This introduction explores the various weed control measures and their implications on the growth and ultimate yield of potato crops, shedding light on the intricate relationship between weed presence and agricultural productivity.

METHODS AND MATERIALS

The experiment was conducted to study the effect of weed management practices on weeds, growth and yield of potato (*Solanum tuberosum* L.) in grid region. The field experiment was conducted at the Directorate of weed science Research (DWSR) Centre, College of Agriculture, (RVSKVV) Gwalior (M.P.) during the *rabi* season of 2016-2017. The experiment was laid out

in randomized block design with 10 treatments replicated three times. The treatments consisted of T_1 White plastic mulch (50 µm), T_2 Black plastic mulch (50 µm), T_3 Straw mulching at 5 DAP (5 t ha^{-1}), T_4 One HW at 20 DAP + Straw mulching at 25 DAP (5 t ha^{-1}), T_5 Two hand hoeing at 20 and 40 DAP, T_6 Two hand weeding at 20 and 40 DAP, T_7 HW at 20 DAP + hoeing at 40 DAP, T_8 Metribuzin @ 500 g/ha pre emergence, T_9 Metribuzin @ 500 g/ha pre emergence + 1HW at 40 DAP, T_{10} Weedy check. Potato variety K. jyoti was sown at the seed rate of 25 q/ha in row of 60 cm apart and 20 cm plant to plant with a basal dose of 180 N + 80 P_2O_5 + 120 K_2O kg/ha through urea, SSP, muriate of potash. The crop was planted on 22 Oct. 2016 and harvested on 15 Feb. 2017. The first irrigation was given immediately after planting since planting was done under dry soil conditions. It ensures proper establishment of potato plant. Subsequent irrigation was given at 10-15 days interval using ridge –furrow irrigation methods as per crop requirement.

Observations Recorded. Five potato plants were randomly selected from the inner rows of each plot. The sampled plants were carefully dugged up, the roots thoroughly washed under running water, put in labeled envelop bags and taken to the laboratory where the growth and yield parameters were recorded. After sun drying samples were oven-dried at 65°C until a constant weight was attained. Completely dried samples were weighed and the dry matter (DM) content of different plant parts was measured and expressed in g $plant^{-1}$. The various Crop growth parameters, *viz*., Plant population, plant height, number of compound leaves and number of stem, fresh and dry weight of plant, Yield attributes and yield, *viz*., number of tuber/plant, tuber weight per plant, haulm per hectare, tuber per hectare and yield biological yield per hectare and harvest Index were recorded. All data related to the study were collected, compiled and statistically analyzed by using the analysis of variance technique. Data so computed was subjected to Fisher's analysis of variance for judging the effect of various treatments.

RESULT AND DISCUSSION

A. Growth parameters

(i) Plant population. Uniform plant density is an important requisite for obtaining higher precision when it is not a variable factor as the treatments. The data in indicate that the plant population remained statistically unchanged (non-significant) under the various treatments without giving any definite trend at 25 DAP. It obviously reflects the fact from these data that the planting of seed tuber was done properly, uniformly in each treatment using healthy and viable sprouted tuber to maintain the better emergence and crop stand. Thus, the crop stand remained almost uniform, sufficient in all the treatments.

(ii) Plant height. In general, the plant height increased with the advancement in crop age irrespective of the treatment and reached maximum at maturity. The rate of increased in plant height was more during 30 to 60 DAP as compared to 60 DAP to maturity. The height of plants was almost ceased or slightly declined at maturity because of senescence.

The plant height varied significantly among the various methods of weed control at all growth stages due to positive effect. At the all the growth stages, Two HW at 20 and 40 DAP and metribuzin @ 500 g/ha pre emergence + 1HW at 40 DAP were found most effective to enhance the plant height to rest of other treatments. While, minimum plant height recorded under weedy check which is comparable to white and black plastic mulch. Arora *et al.* (2009); Kumar (1998); Thakral (1985); Chaudhary *et al.* (2022) in potato who reported that different weed control treatments significantly influenced the plant height.

(iii) Number of stem/plant. The number of stem/plant, in general, was increasing considerably in all the treatment with the progression of plant growth up to harvest.

At the early (30DAP) stage, the number of stem per plant was found to be influenced non significantly due to different treatments of weed control measures, the number ranged between 2.33 to 4.55.

At 60 DAP, the number of stem/plant ranged between 2.66 to 5.25. However, At harvest stage number of compound leaves/plant went up to the range 3.16 to 6.18.These finding are in close vicinity, Robert (1975) ; Chaudhary *et al.* (2022).

(iv) Number of compound leaves/plant. Data related to number of compound leaves/plant at 30, 60 DAP and at harvest. The number of leaves/plant, in general, did not increase considerably in the treatments with the progression of plant growth up to harvest At the early (30 DAP) stage, the number of compound leaves ranged from 18.27 to 30.47, whereas at 60 DAP, it ranged from 31.93 to 48.27, at harvest, number of compound leaves/plant went up to the range from 34.49 to 51.96. The results are also in line with findings of Singh *et al.* (2006); Chaudhary *et al*. (2022).

(v) Fresh and dry weight of plant. Fresh and dry weight of plant, in general, was increasing considerably in all the treatments with the progression of crop growth from initial to up to harvest. Weed control treatments showed significant effect on fresh and dry weight of plant at 60DAP and harvest stage, Weed control treatment T_6 (two hand weeding at 20 and 40 DAP) gave significantly higher fresh and dry weight as compared to other treatments. Further, treatment T_9 (Metribuzin @ 500 g/ha pre emergence + 1HW at 40 DAP) was also gave significantly higher fresh and dry weight followed by T_7 (HW at 20 DAP + hoeing at 40 $DAP_)$, and T_4 (One HW at 20 DAP + Straw mulching at 25 DAP), respectively. The lowest fresh and dry weight/plant was recorded under T_{10} (weedy check) treatment. This was inferior as compared to other treatments. These finding are in close vicinity Gill *et al*. (1983); Shekhawat and Maliwal (1989); Said *et al.* (2019).

B. Yield parameters

(i) Tuber grade and number. The formation of tuber per plant was increased gradually in all the treatments with the encroachment of plant growth up to harvest.

Shekhawat and Maliwal (1989), reported that number of tuber per plant at harvest increased with application of herbicides or hand weeding (6.50- 6.75) as compared to untreated control (4.25).

Different weed control treatments showed significant effect on number of tubers per plant. In case of two hand weeding at 20 and 40 DAP, the number of tuber was higher than the treatment having single hand weeding at 20 DAP. This might be due to the fact that hand weeding in potato affects the crop yield. Reported by Thakral *et al.* (1989); Yadav *et al.* (2014); Singh *et al.* (2014); Said *et al.* (2019); Bankoti *et al.* (2021).

In case of plastic mulch, the effective weed control was achieved with black plastic mulch while the lowest weed control efficacy was obtained with white plastic mulch. Number and dry weight of *weed* seemed to be enhanced under the white plastic mulch condition. Un-controlled potato weeds caused a reduction in total yield. These results are in close proximity of the finding made by Singh and Bhan (1999); Abouziena *et al.* (2015); Chethan *et al.* (2021).

Number of tubers of different grades and total number of tubers per unit area was found lowest in treatment weedy check. The treatments two hand weeding at 20 DAP and 40 DAP, Metribuzin @ 500 g/ha pre emergence + 1HW at 40 DAP and HW at 20 DAP + hoeing at 40 DAP as pre-emergence gave highest number of tubers per unit area. This may be due to better control of weeds during growing season under these treatments. These results are similar to the findings of Singh *et al.* (2014), and Kumar *et al.* (2001).

It is not only total yield, which is important, but yield of different grade tubers is also equally important. The number of tubers also decreased with increase in competition between crop and weeds. In present investigation, effect of competition was quite pronounced on tuber yield, as yield of > 75g size tubers decreased with delay in weed control treatment.

(ii) Biological yield, haulm yield and harvest index. Significant effect due to different weed control treatment was observed on biological yield, haulm yield and harvest index at harvest. Maximum biological yield (231.51 q/ha) was recorded with treatment T_6 (Two hand weeding at 20 and 40 DAP) followed by treatment T_9, T_7, T_4, and T_5 with 227.22, 22.12, 217.93 and 212.12 q/ha biological yield. However, the significantly minimum biological yield (124.83 q/ha) was recorded under weedy check (T_{10}) treatment.

Haulm yield q/ha was increased notably due to effect of various weed control treatments over weedy check. The maximum haulm yield (85.68 q/ha) was recorded under the treatment T_6 (Two hand weeding at 20 and 40 DAP) followed by T_9 (84.86) and treatment T_7 was also gave significantly higher haulm yield. Significantly lowest haulm yield (57.12 q/ha) was recorded under T_{10} (weedy check) treatment.

The data revealed that various weed control treatments have significantly effect on harvest index (%). The significantly higher value of harvest index (63.40 %) was recorded under T_5 (Two hand hoeing at 20 and 40 DAP), closely followed by T_8 (62.93 %), T_6 (62.50 %), T_9(62.09 %), T_7 (61.41 %), T_4 (60.91 %), were also significantly superior over rest of the treatments. The lowest harvest index (64.14 %) registered with T_{10} (Weedy check) treatment.

These finding are in accordance with Gill *et al.* (1983); Singh *et al.* (2007); Abouziena *et al.* (2015).

Table 1a: Effect of different weed control measures on growth parameters at different crop stages.

Treatment	Symbol	Plant population (No. / m^2) at 25 DAP	Plant Height (cm)			Number of leaves/plant			Number of stem/plant		
			30 DAP	60 DAP	Harvest	30 DAP	60 DAP	Harvest	30 DAP	60 DAP	Harvest
White plastic mulch (50 µm)	T_1	7.52	21.80	30.47	31.00	30.47	36.33	39.15	3.13	3.60	4.26
Black plastic mulch (50 µm)	T_2	7.55	22.87	31.33	32.13	25.87	38.20	41.07	3.20	3.70	4.36
Straw mulching at 5 DAP (5 t ha^{-1})	T_3	7.58	23.27	32.40	33.47	25.13	35.73	38.58	3.27	3.76	4.46
One HW at 20 DAP + Straw mulching at 25 DAP (5 t ha^{-1})	T_4	7.80	24.47	35.27	36.20	23.13	38.67	41.65	3.67	4.21	4.98
Two hand hoeing at 20 and 40 DAP	T_5	7.91	24.67	34.87	35.07	24.33	46.33	49.84	3.33	3.84	4.53
Two hand weeding at 20 and 40 DAP	T_6	7.94	26.73	41.27	42.40	26.27	39.87	42.89	4.53	5.25	6.18
HW at 20 DAP + hoeing at 40 DAP	T_7	7.77	24.40	33.47	35.50	23.67	40.53	43.45	3.87	4.45	5.26
Metribuzin @ 500 g/ha pre emergence	T_8	7.64	24.20	33.0	34.17	24.47	48.27	51.96	3.07	3.55	4.19
Metribuzin @ 500 g/ha pre emergence + 1HW at 40 DAP	T_9	7.74	25.53	38.20	39.40	18.27	42.67	45.64	4.13	4.76	5.63
Weedy check	T_{10}	6.86	19.80	27.93	28.90	21.47	31.93	34.49	2.33	2.66	3.16
S.E.(m) ±		0.15	0.80	1.80	1.45	**3.05**	**5.19**	**5.52**	0.46	0.54	0.63
C.D. (at 5%)		NS	2.39	5.35	4.31	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Table 1b: Effect of different weed control measures on growth parameters at different crop stages.

Treatment	Symbol	Fresh weight of plant (g)			Dry weight of plant (g)			Fresh weight of haulm (g)			Dry weight of haulm (g)		
		30 DAP	60 DAP	Harvest	30 DAP	60 DAP	Harvest	30 DAP	60 DAP	Harvest	30 DAP	60 DAP	Harvest
White plastic mulch (50 µm)	T_1	57.00	145.80	192.88	7.54	26.52	40.89	53.00	69.13	77.22	6.78	10.92	15.44
Black plastic mulch (50 µm)	T_2	56.97	156.27	198.62	7.60	28.57	42.10	52.07	71.60	79.95	6.66	11.31	15.99
Straw mulching at 5 DAP (5 t ha^{-1})	T_3	58.87	170.60	206.70	7.81	31.27	43.77	54.40	75.93	85.01	6.96	12.00	17.00
One HW at 20 DAP + Straw mulching at 25 DAP (5 t ha^{-1})	T_4	63.00	200.80	277.90	8.51	36.76	59.14	55.80	89.47	99.90	7.14	14.14	19.98
Two hand hoeing at 20 and 40 DAP	T_5	51.07	190.27	270.04	6.90	34.89	57.53	45.13	84.27	94.04	5.78	13.31	18.81
Two hand weeding at 20 and 40 DAP	T_6	60.40	222.40	306.61	8.14	40.88	65.28	53.73	97.07	108.61	6.88	15.34	21.72
HW at 20 DAP + hoeing at 40 DAP	T_7	59.27	208.40	289.59	8.09	38.12	61.62	51.13	93.73	104.59	6.55	14.81	20.92
Metribuzin @ 500 g/ha pre emergence	T_8	65.93	178.73	255.05	8.95	32.79	54.36	57.73	78.40	87.71	7.39	12.39	17.54
Metribuzin @ 500 g/ha pre emergence + 1HW at 40 DAP	T_9	67.47	218.33	301.66	9.17	40.06	64.22	58.80	95.67	106.99	7.53	15.12	21.40
Weedy check	T_{10}	44.73	114.13	161.92	5.91	20.53	34.30	41.80	59.13	65.92	5.35	9.34	13.18
S.E.(m) ±		**5.61**	**10.27**	**9.96**	**0.73**	**1.87**	**2.08**	**5.53**	**6.36**	**7.12**	**0.71**	**1.00**	**1.42**
C.D. (at 5%)		**NS**	**30.52**	**29.60**	**NS**	**5.56**	**6.18**	**NS**	**18.89**	**21.15**	**NS**	**2.99**	**4.23**

Table 2: Effect of different weed control measures on yield and yield attributes at different crop stages.

Treatment	Symbol	Number of tuber/plant (g)			Tuber fresh weight of plant (g)			Tuber dry weight of plant (g)			Tuber yield (q/ha)	Haulm yield (q/ha)	Harvest index (%)	Biological yield
		30 DAP	60 DAP	Harvest	30 DAP	60 DAP	Harvest	30 DAP	60 DAP	Harvest				
White plastic mulch (50 µm)	T_1	3.07	3.85	4.08	4.00	76.67	115.67	0.76	15.59	25.45	85.07	62.83	56.75	147.90
Black plastic mulch (50 µm)	T_2	3.13	3.90	4.12	4.90	84.67	118.67	0.93	17.26	26.11	88.89	64.46	57.65	153.35
Straw mulching at 5 DAP (5 t ha^{-1})	T_3	3.27	4.10	4.35	4.47	94.67	121.69	0.85	19.27	26.77	92.01	69.36	56.22	161.37
One HW at 20 DAP + Straw mulching at 25 DAP (5 t ha^{-1})	T_4	4.00	5.05	5.37	7.20	111.33	178.00	1.37	22.63	39.16	137.15	80.78	60.91	217.93
Two hand hoeing at 20 and 40 DAP	T_5	3.87	4.83	5.12	5.93	106.00	176.00	1.13	21.57	38.72	135.42	76.70	63.40	212.12
Two hand weeding at 20 and 40 DAP	T_6	4.47	5.58	5.91	6.67	125.33	198.00	1.27	25.54	43.56	145.83	85.68	62.50	231.51
HW at 20 DAP + hoeing at 40 DAP	T_7	4.20	5.26	5.58	8.13	114.67	185.00	1.55	23.31	40.70	138.89	83.23	61.41	222.12
Metribuzin @ 500 g/ha pre emergence	T_8	3.67	4.61	4.89	8.20	100.33	167.33	1.56	20.40	36.81	130.21	70.99	62.93	201.20
Metribuzin @ 500 g/ha pre emergence + 1HW at 40 DAP	T_9	4.40	5.50	5.83	8.67	122.67	194.67	1.65	24.95	42.83	142.36	84.86	62.09	227.22
Weedy check	T_{10}	2.60	3.27	3.47	2.93	55.00	96.00	0.56	11.18	21.12	67.71	57.12	53.84	124.83
S.E.(m) ±		**0.40**	**0.50**	**0.53**	**1.03**	**7.56**	**6.07**	**0.20**	**1.53**	**1.34**	**8.83**	**0.75**	**1.56**	**8.64**
C.D. (at 5%)		**1.19**	**1.49**	**1.58**	**3.07**	**22.46**	**18.03**	**0.58**	**4.54**	**3.97**	**26.23**	**2.24**	**4.64**	**25.67**

CONCLUSIONS

On the basis of above findings, it may be concluded that weed reduced growth, yield attributes and ultimately tuber yield. In organic farming situation weed reduced tuber yield about 50-60 %. Based on the result of this experiment two hand weeding at 20 and 40 DAP find out most effective weed management practice for potato under organic farming in Gwalior region.

— The cost of chemical weed control is actually less than that of manual weeding, hoeing and mulching. This has been a major incentive to many farmers for switching over to herbicides but under organic farming chemical use restricted.

— Hence, it may be concluded that significantly highest plant population (7.94), plant height (26.73, 41.27 and 42.40 cm), number of compound leaves (26.27, 48.27 and 51.96) and number of stem (4.53, 5.25 and 6.18), fresh (60.40, 222.40 and 306.61g) and dry weight of plant (8.14, 40.88 and 65.28 g), fresh weight of haulm /plant (53.73, 97.07 and 108.61 g) and Dry weight of haulm /plant (6.88, 15.34 and 21.72 g) were recorded at 30, 60 and harvest stage respectively.

— Yield attributes and yield parameters, *viz*., Number of tubers plant^{-1} (4.47, 5.58 and 5.91 g), Fresh (6.67, 125.33 and 198 g) and dry weight (1.27, 25.54 and 43.56 g) and tuber yield ha^{-1} (145.83 q) and Biological yield (231.51 q/ha), haulm yield (85.68 q/ha) and harvest index (63.40 %)

— Tuber yield (145.83 q/ha) and Net return (97446.67 Rs./ha) were obtained from two hand weeding at 20 and 40 DAP, followed by HW at 20 DAP + hoeing at 40 DAP (8.39 q/ha, 91474.44 Rs./ha) and Two hand hoeing at 20 and 40 DAP (135.42q/ha, 90363.33 Rs./ha).

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