Plant Archives Vol. 25, No. 1, 2025 pp. 523-528 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org

DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.no.1.079

IMPACT OF DIFFERENT MULCHING STRATEGIES ON WEED DYNAMICS AND ECONOMICS OF RAINFED POTATO

Priyanka Kakati[1], Hridesh Harsha Sarma[1]*, Harihar Chandra Bayan[1], Ratna Kinkar Goswami[2], Digambar Sarma[1], Dipannita Patgiri[4] and Arunima Goswami[5]

[1]Department of Agronomy, Assam Agricultural University, Jorhat, Assam, India.
[2]Department of Crop Physiology, Assam Agriculture University, Jorhat, Assam, India.
[3]Department of Agricultural Statistics, Assam Agricultural University, Jorhat, Assam, India.
[4]Daffodil College of Horticulture and Daffodil, College of Agriculture & Technology, Khetri, Assam, India.
[5]Department of Agronomy, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India.
*Corresponding author E-mail : hrideshsarma.official@gmail.com
(Date of Receiving-13-12-2024; Date of Acceptance-18-02-2025)

ABSTRACT

A field experiment was carried out at P.G Experimental Field, B.N. College of Agriculture, AAU, Biswanath Chariali during *rabi* season (2021-22). The design of the experiment was randomized block design with a total of three replication and eleven treatments *viz*., plastic mulching before planting (T_1), straw mulching after planting (T_2), water hyacinth mulching after planting (T_3), weed mulching after planting (T_4), plastic mulching before planting + hand weeding at 45 DAP (T_5), straw mulching after planting + hand weeding at 45 DAP (T_6), water hyacinth mulching after planting + hand weeding at 45 DAP (T_7), weed mulching after planting + hand weeding at 45 DAP (T_8), earthing up at 25 and 45 DAP (T_9), weed free check (T_{10}), weedy (T_{11}). At 40, 60 DAP and at harvest lowest weed population was observed under water hyacinth mulching + hand weeding at 45 DAP (T_7) and was par with other weed control methods except weedy (T_{11}) at 40 DAP, and T_7 was also at par with all the weed control methods except T_1, T_2, T_5, T_9, T_{11} at 60 DAP and at harvest. At 40, 60 DAP and at harvest, higher weed control efficiency was recorded in water hyacinth mulching + hand weeding at 45 DAP (T_7) and was at par with water hyacinth mulching (T_3), weed mulching (T_4), straw mulching + hand weeding at 45 DAP (T_6), weed mulching + hand weeding at 45 DAP (T_8) and weed free check (T_{10}). The highest gross return of Rs 402000 ha^{-1} was obtained from water hyacinth mulching + hand weeding at 45 DAP (T_7). Highest net return of Rs 248239 ha^{-1} was obtained from the same treatment followed by weed mulching + hand weeding at 45 DAP (T_8). Highest B: C ratio 2.61 was obtained from the same treatment (T_7). Moreover, highest economic efficiency of Rs 2920.46 $ha^{-1}day^{-1}$ was observed in the same treatment.

Key words : Economics, Water hyacinth, Weed control efficiency, Weed population, Mulching.

Introduction

Historical records indicate that the potato was already a well-established garden crop in Surat and Karnataka by 1675. It was introduced to the Simla (now Shimla) hills in 1828 and to the nilgiri hills in 1830. By the late 18th or early 19th century, the potato had become an important and well-established vegetable crop in both the hills and plains of India. However, up until 1941, potato cultivation in the country remained limited, with India contributing less than 1% to the world's potato area and production (Singh and Rana, 2024).

According to the Ministry of Agriculture and Farmers Welfare (Anonymous, 2021), total potato production in Assam was 985.40 thousand tonnes, with an area under cultivation of 115.75 thousand hectares with a productivity of 8513 kg/ha which is very low than average productivity (24102 kg/ha) of our country (Anonymous, 2021).

Potato farming in this landlocked region faces several

challenges, with weeds being the most significant, leading to a notable decline in productivity. Weeds are a major issue in Assam and other Northeastern states due to the crop's slow emergence and weak competitive ability, which allows weeds to thrive. Weed management practices in potato fields are mainly limited to hoeing and herbicide application (Harkar and O'Donovan, 2013). It is well-established that synthetic herbicides leave residual effects on food, soil and water, and their overuse can result in the development of herbicide-resistant weeds. Isik *et al.* (2015) stated that potato crop should be kept weed free until 63 to 66 days after crop emergence to avoid yield loss of more than 5%. Weeds that emerge after 63 to 66 DAE have a competitive disadvantage when compared to potato. Karimmojeni *et al.* (2014) recorded the critical period of weed interference in potato and revealed that the critical period for weed control began 22 days after potato emergence. On account of severe shortage of manual worker and to reduce herbicides uses, soil mulch can be used to control weeds rather than herbicides.

Now days there are more attention on chemical free weed control due to environmental protection and ecological farming. Therefore, mulching as an alternative technique to reduce weed growth in the field can be used. Different kinds of mulches can suppress the weeds in various ways such as block the seed germination stimuli by reducing light interception, fluctuating soil temperature and greatly reduce day-night temperature variation and thus brings less weed seed germination under mulch condition. Moreover, the mulch hurdles the weed emergence even after germination. Some mulch materials like grain straw, fresh cut weeds etc. have allelopathic effect on weed growth. Eventually mulching help in augmenting crop growth and competitiveness against weeds through soil moisture conservation and favorable soil temperature. It also helps in faster plant emergence, early canopy development and higher tuber yield (Mohammad *et al.*, 2002). Hussein and Radwan (2004) reported that mulch system suppressed weeds by shading, lowering soil temperature, allelopathic activity and blocking light required for the germination of many small seeded weed species. Shehata *et al.* (2019) reported that mulch treatment reduced weed plant competition and promotes large tuber production compared to no mulch condition. Research on mulching are crucial for reducing weed populations in potato cultivation as they help identify effective materials that suppress weed growth. They block sunlight, preventing weed seed germination and reduce competition for nutrients and water. This leads to healthier potato plants, higher yields and reduced need for chemical herbicides. Therefore, a study was conducted to generate scientific evidences on effect of mulching strategies on weed dynamics and economics of rainfed potato.

Materials and Methods

During the *rabi* season of 2021-22, field research was conducted at in the field of PG Research, Department of Agronomy, BN College of agriculture, Assam Agricultural University, Biswanath Chariali. The experimental site was 105 m above mean sea level and was located at 26.7^{0}26′42′′ N latitude and 93.5^{0}93′30′′E longitude. The land had a uniformly flat topography and was well-drained. During the crop growth period, it received a total rainfall of 92.2 mm spread over 7 rainy days. The weekly average bright sunshine ranged between 5.0 and 9.3 hours per day. The soil was sandy loam, with a pH of 4.98 (acidic). It contained 0.67% organic carbon (medium level), 278.47 kg/ha of available nitrogen (medium), 17.69 kg/ha of available phosphorus (low) and 119 kg/ha of available potassium (low). The experiment was arranged in a randomized block design with three replication and eleven treatments *viz.*, Plastic mulching before planting, straw mulching after planting, water hyacinth mulching after planting, weed mulching after planting, plastic mulching before planting + hand weeding at 45 DAP, straw mulching after planting + hand weeding at 45 DAP, water hyacinth mulching after planting + hand weeding at 45 DAP, weed mulching after planting + hand weeding at 45 DAP, earthing up at 25 and 45 DAP, weed free check, weedy check (control). Potato variety used for the experimentation was '*Kufri Pukhraj*'. A basal application of the recommended fertilizer dose of 60:50:50 kg N, P_2O_5, K_2O ha^{-1} was made one day prior to planting the potato tubers. The crop was planted in rows at a rate of 22.5 q ha^{-1}, with a row spacing of 45 cm and a plant-to-plant distance of 20 cm. Tubers were planted at a depth of 3-5 cm, with the eyes facing upward and then covered with soil. Plastic mulches with seeding holes were applied a day before planting, while straw, water hyacinth, and weed mulches were applied at a rate of 10 t/ha a day after planting, as per the treatments. Manual hand weeding was performed by pulling weeds from the mulched crop according to the treatments, and earthing up was done manually twice, at 25 DAP and 45 DAP. In the weed-free treatment, hoeing was carried out at 25, 45, and 60 DAP, while the weedy (control) treatment had no weeding operations. Weed species were counted on the basis of quadrant method. They were accurately identified and categorized as grasses, sedges, and broadleaf weeds for each treatment at 20, 40 and 60 DAP, as well as at harvest. Weeds were sampled from a 0.25 m² area in each plot at these same

stages, counted, and then dried in an oven at 70 ºC until a constant weight was achieved. The weed biomass was expressed in g m^{-2}. Data collected from the experiment were analyzed using ANOVA and the significance was determined using Fisher's least significant difference (p = 0.05%).

Results and Discussion

In the experimental plot, the weed flora consists of grasses, sedges and broad-leaved weeds. The most common weeds found in the experimental field were *Cynodon dactylon* (L.) Pers., *Digitaria sanguinallis* (L.) Scop., *Cyperus rotundus* (L.), *Cyperus iria* (L.), *Ageratum conyzoides* (L.) Briq., *Amaranthus viridis* (L.), *Aristolochia bracteolate* (L.), *Borreria hispida* (L.), *Eleusine indica* (L.) Gaertn., *Imperata cylindrica* (L.) Beauv., *Seteria glauca* (L.) Beauv., *Celosia argentea* etc.

The data revealed that lowest weed population was recorded at 'water hyacinth mulching + hand weeding at 45 DAP (T_7) and plastic mulching + hand weeding at 45 DAP (T_5) and both were statistically at par with plastic mulching (T_1), water hyacinth mulching (T_3) and weed mulching + Hand weeding at 45 DAP (T_8) at 20 DAP. However, at 40, 60 DAP and at harvest lowest weed population was observed under water hyacinth mulching + hand weeding at 45 DAP (T_7) and was par with other weed control methods except weedy (T_{11}) at 40 DAP, and former one water hyacinth mulching + hand weeding at 45 DAP (T_7) was also comparable with all the weed control methods except 'Plastic mulching (T_1), 'Straw mulching after planting (T_2), 'Plastic mulching + hand weeding at 45 DAP (T_5), earthing up at 25 and 45 DAP (T_9) and weedy (T_{11}) at 60 DAP and at harvest. Lower weed populations were observed with the combination of 'Water hyacinth mulching + Hand weeding at 45 DAP' across all growth stages. This could be attributed to the water hyacinth mulch blocking weed germination signals, its allelopathic properties, and the establishment of a weed-free environment through hand weeding at later growth stages. Hussein and Radwan (2004) also opined allelopathic effect of water hyacinth mulch on weed

Table 1 : Effect of mulching strategies on weed populations (nos./m^2).

Treatment	20 DAP	40 DAP	60 DAP	At harvest
T_1: Plastic mulching	7.70 (59.44)*	7.12 (50.72)	5.27 (27.80)	3.62 (13.27)
T_2: Straw mulching	10.14 (103.52)	6.89 (47.68)	5.24 (27.52)	3.58 (13.00)
T_3: Water hyacinth mulching	7.59 (59.52)	6.85 (47.12)	4.57 (20.89)	2.52 (6.37)
T_4: Weed mulching	9.01 (81.84)	6.65 (44.33)	4.70 (22.19)	2.73 (7.67)
T_5: Plastic mulching + HW at 45 DAP	7.24 (52.52)	7.62 (58.13)	5.37 (28.00)	3.77 (14.25)
T_6: Straw mulching + HW at 45 DAP	9.17 (84.35)	7.16 (51.38)	4.74 (22.52)	2.80 (8.00)
T_7: Water hyacinth mulching + HW at 45 DAP	7.24 (52.52)	6.17 (38.52)	4.34 (18.85)	2.06 (4.33)
T_8: Weed mulching + HW at 45 DAP	8.46 (72.91)	6.20 (38.52)	4.37 (18.95)	2.10 (4.67)
T_9: Earthing up at 25 and 45 DAP	13.84 (191.84)	6.85 (47.18)	5.01 (25.19)	3.24 (10.67)
T_{10}: Weed free check	13.95 (194.67)	6.55 (42.97)	4.35 (19.19)	2.10 (4.43)
T_{11}: Weedy (Control)	15.57 (243.33)	15.00 (225.00)	13.96 (195.00)	12.60 (158.71)
SEd±	0.77	0.37	0.22	0.36
C.D (P=0.05)	1.60	1.76	0.45	0.76

*Square root transformed [(x + 0.5)] value, where x = observed value. The original values are presented in the parentheses.

Table 2 : Effect of mulching strategies on weed dry weight (g m^{-2}).

Treatment	20 DAP	40 DAP	60 DAP	At harvest
T_1: Plastic mulching	2.78	13.06	18.26	23.05
T_2: Straw mulching	3.58	10.54	15.74	18.10
T_3: Water hyacinth mulching	2.81	7.15	12.35	16.63
T_4: Weed mulching	2.87	7.53	12.73	17.20
T_5: Plastic mulching + HW at 45 DAP	2.73	11.89	17.09	19.66
T_6: Straw mulching + HW at 45 DAP	2.85	8.73	13.93	17.44
T_7: Water hyacinth mulching + HW at 45 DAP	2.80	6.80	12.00	14.70
T_8: Weed mulching + HW at 45 DAP	2.81	6.92	12.12	15.20
T_9: Earthing up at 25 and 45 DAP	3.64	9.81	15.01	17.47
T_{10}: Weed free check	3.52	6.98	12.18	16.23
T_{11}: Weedy (Control)	3.83	30.26	58.57	93.67
SEd ±	0.32	1.50	0.86	3.44
C.D (P=0.05)	0.67	3.13	1.80	7.19

HW: Hand weeding; DAP: Days after planting.

Table 3 : Effect of mulching strategies on weed control efficiency (%).

Treatment	20 DAP	40 DAP	60 DAP	At harvest
T_1: Plastic mulching	75.09	77.48	85.69	91.64
T_2: Straw mulching	57.66	78.63	85.91	91.78
T_3: Water hyacinth mulching	74.94	80.25	89.27	95.96
T_4: Weed mulching	65.26	78.96	88.57	95.16
T_5: Plastic mulching + HW at 45 DAP	78.33	74.17	85.16	90.96
T_6: Straw mulching + HW at 45 DAP	65.23	77.17	88.45	94.88
T_7: Water hyacinth mulching + HW at 45 DAP	78.31	82.89	90.42	97.28
T_8: Weed mulching + HW at 45 DAP	69.05	82.13	90.33	97.06
T_9: Earthing up at 25 and 45 DAP	20.09	78.92	87.06	93.2
T_{10}: Weed free check	18.69	80.72	90.01	97.19
T_{11}: Weedy (Control)	-	-	-	-
SEd ±	4.17	1.57	0.97	1.75
C.D (P=0.05)	8.73	3.29	2.02	3.64

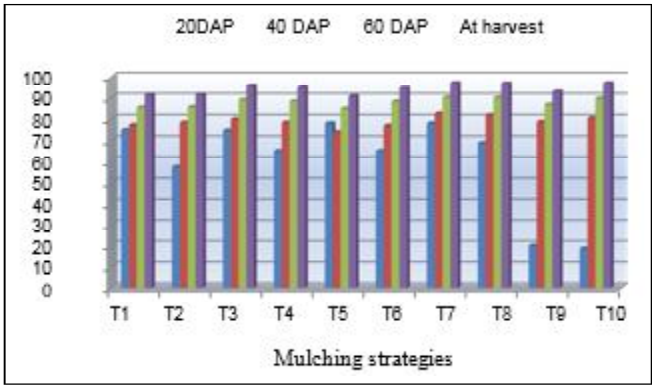

Fig. 1 : Effect of mulching strategies on weed control efficiency WCE (%).

suppression. Highest weed population was recorded under weedy as it remained un weeded throughout the crop growth period and this was also in agreement with findings from Khan *et al*. (2008).

At 20 DAP, weed control methods significantly reduced weed biomass over weedy plot, except earthing up at 25 and 45 DAP (T_9) and weed free (T_{10}) and these two treatments were statistically at par with weedy (T_{11}) at 20 DAP. Minimum weed dry weight was recorded with plastic mulching + hand weeding at 45 DAP' at 20 DAP, likely due to the difficulty young weed seedlings faced in penetrating the tough plastic surface. Additionally, the absence of photosynthetically active radiation beneath the plastic mulch may have slowed the germination rate or completely inhibited the germination of weed seeds. This result is in line with Uremis *et al*. (2009), Rajablarani *et al*. (2012) and Mazumder *et al*. (2016). At 40, 60 DAP and at harvest, lowest weed dry weight was recorded in water hyacinth mulching + hand weeding at 45 DAP (T_7) and was at par with weed mulching + hand weeding at 45 DAP (T_8). However, lower weed dry weight was found at water hyacinth mulching + hand weeding at 45 DAP (T_7) at in 40 DAP, 60 DAP and at harvest. This could be attributed to the weed-suppressing properties of water hyacinth mulch, which helped reduce competition between weeds and the crop during the later stages of growth. Similar trend was reported by Barman *et al*. (2008), Khan *et al*. (2008) and Shehata *et al*. (2019) in potato. At all the crop growth stages, weedy (T_{11}) recorded highest weed dry weight which might be due to competitive advantages of weeds over crop. Similar finding was opined by Bobby *et al*. (2017) and Bankoti *et al*. (2021) in potato

Plastic mulching + hand weeding at 45 DAP (T_5) recorded highest weed control efficiency and was statistically at par with water hyacinth mulching + hand weeding at 45 DAP (T_7), water hyacinth mulching (T_3)

Table 4 : Effect of mulching strategies on economics of potato.

Treatment	Cost of cultivation (Rs ha^{-1})	Gross return (Rs ha^{-1})	Net Return (Rs ha^{-1})	B:C ratio	Economic efficiency (Rs h^{-1}day^{-1})
T_1: Plastic mulching	222841	245760	22918	1.10	269.63
T_2: Straw mulching	136497	257320	120822	1.89	1421.44
T_3: Water hyacinth mulching	132497	310240	177742	2.34	2091.08
T_4: Weed mulching	132497	299600	167102	2.26	1965.91
T_5: Plastic mulching + HW at 45 DAP	244104	293540	49435	1.20	581.59
T_6: Straw mulching + HW at 45 DAP	157761	301300	143539	1.91	1688.69
T_7: Water hyacinth mulching + HW at 45 DAP	153761	402000	248239	2.61	2920.46
T_8: Weed mulching + HW at 45 DAP	153761	391960	238199	2.55	2802.34
T_9: Earthing up at 25 and 45 DAP	165911	291760	125849	1.76	1480.58
T_{10}: Weed free check	162873	346540	183666	2.13	2372.54
T_{11}: Weedy (Control)	123385	204860	81475	1.66	958.53

and plastic mulching (T_1). At 40, 60 DAP and at harvest higher weed control efficiency were recorded in water hyacinth mulching + hand weeding at 45 DAP (T_7) and was statistically at par with water hyacinth mulching (T_3), weed mulching (T_4), straw mulching + hand weeding at 45 DAP (T_6), weed mulching + hand weeding at 45 DAP (T_8) and weed free check (T_{10}) except weed mulching (T_4) and straw mulching + hand weeding at 45 DAP (T_6) were inferior to water hyacinth mulching + hand weeding at 45 DAP (T_7). Plastic mulching + hand weeding at 45 DAP (T_5) resulted in highest weed control efficiency at early crop growth stage due to decrease in weed seed germination and weed infestation was likely due to the reduced solar radiation penetration under the black plastic mulch. This result was in line with Aniekwe and Nwite (2013), Bobby *et al.* (2017) in cucumber, Choudhary *et al.* (2012) in capsicum. At later growth stages weed control efficiency was found highest under T_7 and this could be attributed to the stronger weed suppression and allelopathic effects of water hyacinth during the early growth stages, which led to reduced competition between weeds and the crop. Similar finding was also reported by Jaiswal and Lal (1996) and Khan *et al.* (2008).

The highest gross return (Rs 402000 ha^{-1}) was obtained from water hyacinth mulching + hand weeding at 45 DAP (T_7). Highest net return (Rs 248239 ha^{-1}) was obtained from the same treatment followed by weed mulching + hand weeding at 45 DAP (T_8). The same treatment T_7 also recorded highest B: C ratio 2.61. This might be due to higher weed control efficiency and yield which was reflected in higher gross return as compared to cost of cultivation. Moreover, highest economic efficiency (Rs 2920.46 ha^{-1}day^{-1}) was observed in water hyacinth mulching + hand weeding at 45 DAP (T_7) and was significantly superior over other weed control methods. This might be due to lowest cost of cultivation. Plastic mulching (T_1) recorded lowest economic efficiency (Rs 269.63 ha^{-1}day^{-1}), which might be due to maximum cost of cultivation involved under plastic mulch.

Conclusion

Water hyacinth mulching after planting + hand weeding at 45 days after planting can be suggested as a better treatment for effective control of weed dynamics, higher weed control efficiency with profitable economic output. As this study is based on a one-year experiment, conducting further research over multiple years would be beneficial to better validate the results.

References

Aniekwe, N.L. and Nwitwe P.O. (2013). Influence of Transparent and Black Plastic mulches and Staking on the Enviroment, Growth and yield of Cucumber (*Cucumis sativus* L.) in Abakaliki, Southern Nigeria. *Int. J. Sci. Res.*, **9(2)**, 2319-7064.

Anonymous (2021). *Department of Agricultural Farmers & Welfare*. Directorate of Economics & Statistics, GoI, New Delhi. Pp 163- 165.

Bankoti, P., Bohra S.C., Shubham, Nikhilesh, Kumar A. and Sharma V. (2021). Effect of various weed management methods on growth and yield of potato (*Solanum tuberosum* L.). *J. Pharmacogn. Phytochem.*, **10(1)**, 1720-1724.

Barman, K.K., Khankhane P.J. and Varshney G.J. (2008). Effect of mulching on weed infestation and tuber yield of potato in black cotton soil. *Indian J. Weed Sci.*, **40 (3&4)**, 136-139.

Bobby, A., Prashanth P., Seenivassaan N. and Mishra P. (2017). Effect of Different mulch material on weed control in cucumber (*Cucumis sativus* L.) hybrid "Multistar" under

shade net conditions. *Int. J. Pure. App. Biosci.,* **5(5)**, 1246- 1251.

Choudhary, V.K., Bhambri M.C., Pandey N. and Sharma H.G.(2012). Effect of drip irrigation and mulches on physiological parameters, soil temperature, picking pattern and yield in capsicum (*Capsicum annuum* L.) *Arch. Agron. Soil Sci*., **58(3)**, 277-292.

Harkar, K.N. and Odonovan J.T. (2013). Recent weed control. Weed management and integrated weed management. *Weed Technol*., **27 (1)**, 11

Hussein, H.F. and Radwan S.M.A. (2004). Associative action between bio-organic farming & safety weed control methods on pea productivity. *Proc. in Symposium on scientific research and technological development outlook in the arab world*, 3 Cairo.

Isik, D., Akca A., Kayaaltop E., Tursun N. and Mennan H. (2015). The Critical Period for Weed Control (CPWC) in Potato (*Solanum tuberosum* L.). *Not Bot Horti Agrobo*., **43 (2)**, 355-360.

Jaiswal, V.P. and Lal S.S. (1996). Efficacy of cultural and chemical weed control methods in potato (*Solanum tuberosum*). *Indian J. Argon.*, **41(3)**, 454-456.

Karimmojeni, H., Barjasteh A., Mousavi R.S. and Bazrafshan A.H. (2014). Determination of critical period of weed control in potato (*Solanum tuberosum* L.). *N. Z. J. Crop Hortic.*, **42(3)**, 151-160.

Khan, A.S.A., Hossain M.A., Mahmud A.A., Howlader M.I.A. and Rahman M.A. (2008). Integrated Weed Management in Potato at Munshigonj. *Bangladesh J. Agril. Res.*, **33(3)**, 647-654.

Mazumder, D.A., Nath S.C., Kabir M.A. and Majumder S. (2016). Effect of mulching materials on mini-tuber production of potato from in vitro plantlets. *Nusantara Bioscience*, **8**, 123-127.

Mohammad, M.M., Farooq K., Hussain A. and Sher R. (2002). Effect of mulching on growth and yield of potato crop. *Asian J Plant Sci*., **2**, 132-33.

Mohammad, M.M., Farooq K., Hussain A. and Sher R. (2002). Effect of mulching on growth and yield of potato crop. *Asian J. Pl. Sci.*, **2**, 132-133.

Rajablarani, H., Hassankhan R.F. and Rafezi R. (2012). Effect of coloured plastic mulches on yield of tomato and weed biomass. *J. Environ. Sci. Dev*., **3(6)**, 590-593.

Shehata, S.A., Abouziena H.F., Abdelgawad K.F. and Elkhawaga F.A. (2019). Weed control efficacy , growth and yield of potato (*Solanum tuberosum*) as affected by alternatives weed control methods. *Potato. Res*., **62**, 139-155.

Singh, B.P. and Rana R.K. (2014, November). History of potato and its emerging problems in India. In *Souvenir–National Seminar on Emerging Problems in Potato. Shimla, India: Indian Potato Association* (pp. 7-21).

Uremis, I., Caliskan M.E., Uludag A. and Caliskan S. (2009). Weed management in in early season potato production in Mediterranean condition of Turkey. *Bulgarian J. Agric. Sci.,* **15(5)**, 423-434.