Plant Archives Vol. 25, No. 1, 2025 pp. 764-768 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.1.115

EVALUATION OF MULCHING STRATEGIES ON GROWTH PERFORMANCE AND YIELD OF RAINFED POTATO

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(Date of Receiving-09-12-2024; Date of Acceptance-18-02-2025)

ABSTRACT

A field experiment was carried out during *rabi season* at P.G Experimental Field, B.N College of Agriculture, AAU, Biswanath Chariali during 2021-22.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 (control). Highest plant height (63.75 cm) and leaves plant^{-1} (60.90) was observed under water hyacinth mulching after planting + hand weeding at 45 DAP (T_7). Also, branches plant^{-1} (9.91) was observed to be higher in the same treatment which was at par with weed mulching + hand weeding at 45 DAP (T_8) (9.09). Leaf area Index was also found to be maximum (3.16) under the same treatment. T_7 also recorded higher dry matter accumulation (97.98 g plant $^{-1}$) at harvest, which was at par with T_8 (95.45 g plant^{-1}). Highest number of small tubers (6.11) plant^{-1} was recorded under weedy (T_{11}). Maximum number of medium (9.52) and big (3.78) tuber size were observed under T_7. The same treatment also recorded higher tuber yield (201.00 q ha^{-1}) among the weed control methods which was at par with T_8 (195.98 q ha^{-1}).

Key words : Dry matter accumulation, Mulching, Plant height, Tuber yield, Water hyacinth.

Introduction

Potatoes have been cultivated in the country for over 300 years and serve as an affordable source of energy, starch, vitamins (particularly vitamin B and C), and minerals. They contain 20.6% carbohydrates, 2.1% protein, 0.3% fat, 1.1% crude fiber and 0.9% ash. Additionally, potatoes are rich in essential amino acids like leucine, tryptophan and isoleucine. Potato protein has a higher biological value compared to cereal proteins, and it even surpasses milk protein in quality. Potatoes are also used in various industrial applications, including starch and alcohol production. Potato starch (farina) is utilized in laundries and textile mills to size yarn. Furthermore, potatoes are processed into products such as dextrin, glucose, potato chips and shredded potatoes.

Given the rising global population (Thiele *et al.*, 2010), potatoes play a crucial role in food security. They are a significant crop in India's North Eastern Region, with Assam leading in both the area under cultivation and potato production (Yadav *et al.*, 2014). However, potato farming in this landlocked region faces several challenges, the most critical being weed infestation, which severely reduces potato productivity. Weeds are a major concern in Assam and other Northeastern states, as the slow emergence of potato plants and their weak competitive ability against weeds allows weed growth to flourish. Weed

invasion has been reported to reduce potato tuber yields by 34.4% to 86.0% (Monteiro *et al*., 2011; Yadav *et al*., 2014b). In addition to the direct financial losses from reduced yields, weed presence depletes soil fertility. Effective weed control has been shown to improve potato tuber yields by 18-22%. The primary methods of weed management in potato fields are limited to hoeing and herbicide application. However, the use of synthetic herbicides raises concerns about their residual effects on food, soil and water (Serajchi *et al*., 2013). As a result, there is growing interest in chemical-free weed control methods, such as ecological farming and environmental protection.

Mulching has emerged as a viable alternative to reduce weed growth. Various types of mulches suppress weeds by blocking light necessary for seed germination, reducing soil temperature fluctuations, and providing a stable day-night temperature that inhibits weed seed germination. Moreover, mulching promotes better crop growth and competitiveness against weeds by conserving soil moisture and maintaining favourable soil temperatures. Keeping this under consideration, research was conducted to examine the effect of mulching on growth, development and yield of potato.

Materials and Methods

Field research was conducted during the *rabi* season, 2021-22 in the field of PG Research, Department of Agronomy, Biswanath 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 topography of the land was uniformly plain and well drained. The total amount of rainfall received during crop growth period was 92.2 mm in 7 rainy days. The weekly mean bright sunshine ranged from 5.0 to 9.3 hours day $^{-1}$. The soil was classified as sandy loam, with a pH level of 4.98 (acidic), organic carbon content at 0.67% (medium), available nitrogen at 278.47 kg/ha (Medium), available phosphorus at 17.69 kg/ha (low) and available potassium at 119 kg/ha (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 '*Kufri Pukhraj*' was taken for the experimentation. The recommended dose is 60:50:50 kg N, P_2O_5, K_2O ha^{-1} fertilizer was applied as a basal application one day before potato tuber planting. Nitrogenous, phosphatic and potassic fertilizers were applied in the form of urea, SSP and MOP. Crop was planted in rows @ 22.5 q ha^{-1} with spacing of 45cm in row-row and plant-plant distance was 20 cm. The tuber was planted at a depth of 3-5 cm with upward facing eyes and finally covered with soil. Plastic mulches with seeding holes by maintaining proper spacing were applied a day before the planting and straw mulches, water hyacinth mulches and weed mulches were applied @ 10t/ha a day after the planting of potato tuber as per treatments. Manual hand weeding was done by pulling weeds under mulched crop as per treatments and earthing up was done manually twice at 25 DAP and 45 DAP. Weed free treatment was maintained by hoeing at 25, 45 and 60 DAP and weedy (control) treatment was maintained without any weeding operation. Data related to the experiment were analysed by ANOVA and the significance was determined by using Fisher's least significance difference (p = 0.05%).

Results and Discussion

At harvest, among the treatments, highest plant height (63.75 cm) and leaves plant^{-1} (60.90) was observed under water hyacinth mulching after planting + hand weeding at 45 DAP (T_7). The increased plant height and number of leaves per plant can likely be attributed to the weed-free conditions during the early stages of crop growth. Water hyacinth helped suppress weed growth, reducing the competition between the crop and weeds at critical growth periods. Additionally, the high and consistent soil moisture levels facilitated better water and nutrient absorption by the crop compared to crops without mulch. Similar observations were made in studies by Satapathy *et al*. (2016), Chettri and Goswami (2018). Also, branches plant^{-1} (9.91) was observed to be higher in the same treatment which was at par with weed mulching + hand weeding at 45 DAP (T_8) (9.09). Leaf area Index was also found to be maximum (3.16) under the same treatment of water hyacinth mulching after planting + Hand weeding at 45 DAP (T_7) at 60 DAS. The observed benefits of water hyacinth mulching can be attributed to its weed suppression properties, which reduced crop-weed competition, helped retain more stable soil moisture, and created a more favorable thermal environment for crops, all of which contributed to improved growth. These effects persisted for a longer duration under the mulched conditions. These results align with previous studies by Ghosh and De (2011), Apotikar (2012), Satapathy *et al*.

Table 1 : Effect of weed control methods on growth parameters of potato at harvest.

Treatment	Plant height (cm)	Green leaves plant^{-1} (Nos.)	Branch plant^{-1} (Nos.)	Leaf Area Index (60 DAS)	Chlorophyll content (60 DAS)	Crop dry matter (g plant $^{-1}$)
T_1: Plastic mulching	46.00	39.12	6.12	1.82	34.53	69.87
T_2: Straw mulching	46.98	44.01	6.30	2.52	36.27	75.45
T_3: Water hyacinth mulching	53.98	52.23	6.74	3.07	38.73	87.67
T_4: Weed mulching	52.88	51.34	6.63	2.38	38.60	85.90
T_5: Plastic mulching + HW at 45 DAP	43.78	37.34	6.08	1.95	33.37	65.23
T_6: Straw mulching + HW at 45 DAP	52.22	45.90	6.52	1.82	37.23	81.35
T_7: Water hyacinth mulching + HW at 45 DAP	63.75	60.90	9.91	3.16	40.63	97.98
T_8: Weed mulching + HW at 45 DAP	56.71	54.23	9.09	2.79	40.37	95.45
T_9: Earthing up at 25 and 45 DAP	50.11	44.45	6.41	2.12	36.57	79.66
T_{10}: Weed free check	55.14	52.67	7.08	2.38	39.67	92.12
T_{11}: Weedy (Control)	39.78	33.79	5.85	1.53	30.77	65.36
SEd±	1.68	2.14	0.87	0.28	3.56	2.14
C.D (P=0.05)	3.51	4.47	1.82	0.59	NS	4.48

DAP: Days after planting; HW: Hand weeding.

(2016), Begum and Saikia (2014) and Panging (2018), who also found that mulching significantly increased the Leaf Area Index (LAI) of potatoes compared to crops without mulch.

However, there was no significant variation observed in leaf chlorophyll content index. T_7 also recorded higher dry matter accumulation (97.98 g plant $^{-1}$) at harvest which was at par with T_8 (95.45 g plant^{-1}). It is obvious that maximum plant height, branches plant^{-1}, leaves plant^{-1} and LAI under 'Water hyacinth mulching + hand weeding' at 45 DAP resulted in higher crop dry matter production. The low weed populations and reduced weed-crop competition during critical growth phases contributed to a higher Leaf Area Index (LAI), which in turn enhanced photosynthesis and increased crop dry matter. These findings are consistent with the work of Bukan (2004). Additionally, the improved hydrothermal conditions, coupled with a more extensive canopy, could explain the greater dry matter observed in T_7. This aligns with the observations of Khurana and McLaren (1982) and Chetri and Goswami (2018). Furthermore, Chakravarti *et al*. (2010) suggested that water hyacinth mulching positively impacted dry matter production and groundnut yield by modifying the thermal environment. Lowest growth parameters were reported under weedy treatment (T_{11}).

Maximum tubers plants^{-1} (15.77) were recorded in water hyacinth mulch + hand weeding at 45 DAP (T_7) which was at par with weed mulching + hand weeding at 45 DAP (T_8), Weed free check (T_{10}), Straw mulching + hand weeding at 45 DAP (T_6) and earthing up at 25 and 45 DAP (T_9). Highest tuber weight (59.22 g) was recorded under 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), 'Weed mulching + Hand weeding at 45 DAP (T_8) and weed free check (T_{10}).

Highest tuber diameter of 6.22 cm was observed in water hyacinth mulching + hand weeding at 45 DAP (T_7) and was statistically at par with weed mulching + hand weeding at 45 DAP (T_8) and weed free check (T_{10}). The increased tuber weight of potato can likely be attributed to improved soil moisture, favourable soil temperature, and weed suppression by water hyacinth during the early stages of crop growth. Additionally, the weed-free conditions established through hand weeding at critical growth stages further contributed to enhanced yield attributes. These findings are consistent with those of Uniyal and Mishra (2003), Hussein *et al*. (2016) and Mohaniya *et al*. (2020).

Highest number of small tubers (6.11) plant^{-1} was recorded under weedy (T_{11}) and lowest (2.18) was under water hyacinth mulching + hand weeding at 45 DAP (T_7) and later one at par with weed mulching + hand weeding at 45 DAP (T_8) and weed free check (T_{10}). Maximum

Table 2 : Effect of weed control methods on tuber development.

Treatment	Tuber plant^{-1} (Nos.)	Tuber weight (g)	Tuber diameter (cm)
T_1: Plastic mulching	10.71	43.80	4.78
T_2: Straw mulching	11.66	44.96	4.88
T_3: Water hyacinth mulching	12.82	51.05	5.25
T_4: Weed mulching	12.47	50.00	5.11
T_5: Plastic mulching + HW at 45 DAP	10.74	45.28	4.94
T_6: Straw mulching + HW at 45 DAP	13.18	48.5	4.95
T_7: Water hyacinth mulching + HW at 45 DAP	15.77	59.22	6.22
T_8: Weed mulching + HW at 45 DAP	14.89	54.09	5.86
T_9: Earthing up at 25 and 45 DAP	13.17	48.47	4.87
T_{10}: Weed free check	14.57	53.55	5.40
T_{11}: Weedy (Control)	9.87	32.84	4.75
SEd ±	1.25	4.66	0.42
C.D (P=0.05)	2.61	9.72	0.88

Table 3 : Effect of weed control methods on tuber yield.

Treatment	Small tuber plant^{-1} (Nos.)	Medium tuber plant^{-1} (Nos.)	Large tuber plant^{-1} (Nos.)	Green potato plant^{-1} (Nos.)	Tuber yield (q ha^{-1})
T_1: Plastic mulching	5.12	4.44	1.91	1.60	122.88
T_2: Straw mulching	6.02	4.32	1.80	2.05	128.66
T_3: Water hyacinth mulching	3.42	6.12	1.99	1.18	155.12
T_4: Weed mulching	4.71	6.55	2.09	1.73	149.80
T_5: Plastic mulching + HW at 45 DAP	6.78	2.08	1.77	1.07	146.77
T_6: Straw mulching + HW at 45 DAP	3.57	6.93	2.68	1.67	150.65
T_7: Water hyacinth mulching + HW at 45 DAP	2.18	9.52	3.78	1.06	201.00
T_8: Weed mulching + HW at 45 DAP	2.47	8.64	3.67	1.75	195.98
T_9: Earthing up at 25 and 45 DAP	4.12	6.92	2.29	1.53	145.88
T_{10}: Weed free check	3.07	8.32	2.78	2.23	173.27
T_{11}: Weedy (Control)	6.11	2.23	1.71	2.71	102.43
SEd±	0.48	0.61	0.47	0.24	5.54
C.D. (P=0.05)	1.00	1.27	0.98	0.50	11.58

number of medium (9.52) and big (3.78) tuber size were recorded under water hyacinth mulching + hand weeding at 45 DAP (T_7) and was at par with weed mulching + hand weeding at 45 DAP (T_8) and weed free check (T_{10}). Water hyacinth mulching + hand weeding at 45 DAP (T_7) recorded significantly higher tuber yield (201.00 q ha^{-1}) among the weed control methods which was at par with weed mulching + hand weeding at 45 DAP (195.98 q ha^{-1}). Lowest green tubers plant^{-1} (1.06) was observed under water hyacinth mulch + hand weeding at 45 DAP (T_7) and was at par with plastic mulching + hand weeding at 45 DAP (T_5), water hyacinth mulching (T_3) and earthing up at 25 and 45 DAP (T_9). The higher tuber yield observed can be attributed to enhanced vegetative growth, including increased plant height and Leaf Area Index (LAI), along with maximum crop dry matter production and greater tuber weight per plant. Hand weeding at critical growth stages minimized crop-weed competition for essential growth resources, creating a favorable environment for optimal crop growth and tuber yield. Satapathy *et al*. (2016), Panging (2018) and Pathak *et al*. (2021) also reported increased potato yields under water hyacinth mulching. The lowest yield was noted in the weedy plot (T_{11}), where weed competition and the pressure of weed biomass negatively impacted tuber yield. A similar trend was observed by Mondani *et al*. (2011).

Conclusion

Water hyacinth mulching after planting + hand weeding at 45 DAP is the best treatment for better growth, development and yield of potato followed by weed

mulching + hand weeding at 45 DAP. Since, this study is based on a one-year experimentation, additional research over multiple years will be much helpful to further validate the findings.

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