

Potato (*Solanum tuberosum* L.) soil covering with organic matter: Results and knowledge gap

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ABSTRACT

Potato mulching practices and their effects often differ, and the results are sometimes contradictory in the literature, as they vary depending on climatic conditions and growing practices. In this study, we analysed 68 peer-reviewed publications to reveal which problems of potato cultivation were intended to be solved by mulching with organic materials. We have found that the main goals of mulching are the preservation of soil moisture, the reduction of soil temperature, and the suppression of weeds, in which mulching provides effective help. In different parts of the world, different organic mulches increased the yield of potatoes in 78% of the studies. Although the occurrence and damage of pests, pathogens and weeds are extremely understudied (16, 18, 29% of the studies), we can conclude that organic mulches effectively reduced their damage.

KEYWORDS

potato, organic mulch, soil-dwelling pests, soil-born pathogens

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INTRODUCTION

Mulching has become increasingly popular in the last 30 years and has become an important method of soil protection in crop production. All this is proven and supported by the increasing number of scientific articles on the subject.

Potato (*Solanum tuberosum* L.) is the most important non-cereal food crop and the fourth most important crop in the world after wheat, rice and corn (Shijie, 2011). Mulching can be easily and effectively incorporated into the cultivation technology of potatoes. Potatoes are very sensitive to soil-water conditions, a lack of water leads to a significant reduction in yield (Wellings, 1973; Steduto et al., 2012). In many cases, its extremely high need for irrigation can be attributed to the cooling effect of frequent water treatment rather than to sensitivity to soil moisture stress (Burgers and Nel, 1984). Yamaguchi et al. (1964) showed that as the soil temperature rises above 20 °C, the rate of tuber respiration increases at the cost of tuber development.

Covering the soil with various organic materials reduces soil moisture loss and lowers soil temperature (Chang et al., 2020; Goel et al., 2020). It successfully suppresses weed growth (Barman et al., 2008), provides shelter to natural enemies (Brust, 1994; Dudás et al., 2016a), promotes microbial growth (Bharati et al., 2020), and even prevents certain diseases, e.g. it also reduces the occurrence of the PVY virus (Saucke and Döring, 2004), the infection of *Phytophthora infestans* (Dvořák et al., 2010), and the number of scabby and green tubers (Majumder et al., 2016). Soil cover prevents soil erosion and compaction (Edwards et al., 2000b), leaching of nutrients (Döring et al., 2005), or helps their absorption from the soil (Kar and Kumar, 2007; Dvořák et al., 2013; Ramírez et al., 2022), thus maintaining soil fertility (Nowroz et al., 2021).

As a result of all this, a significant yield increase can be achieved with organic mulching, which is also reported by the vast majority of studies dealing with potato mulching (Li et al., 2018; Wang et al., 2019). In addition to increasing yields, mulching also has a positive effect on the content of potato tubers (Dvořák et al., 2009).

In addition to mulching, the introduction of conservation tillage (no tillage) gave further positive results. It significantly increased the water use efficiency and thereby the yield of potatoes (Hou and Lí, 2019; Ramírez et al., 2022), and also improved the quality (Sarangi et al., 2020).

These beneficial effects can only be achieved if the mulching is carried out in the appropriate way, with the right material and at the right time. It is also important to consider what the main purpose of mulching is in the given climate: reducing soil loss, restoring soil, replenishing nutrients, preserving soil moisture, or reducing temperature fluctuations, attracting natural enemies, stimulating soil life, or simply increasing yield.

In this study, we processed 68 articles which examined the effect of 28 types of organic mulches in potato plantations. Our aim was to quantify the main problems in potato cultivation, for which solutions are being sought in different parts of the world through soil covering. We focused on the cultivation technology of potatoes and the methodology of soil mulching, as well as their effect on pests and ultimately on the yield, in order to be able to determine which topics received sufficient attention, how similar the obtained results are, and which topics await further research.



MATERIAL AND METHODS

During our research, we searched peer-reviewed publications until December 2022 to collect data on the effects of mulching with different organic mulches in potato plantations. Data published in English were collected from the publicly available Google Scholar website. We carried out the collection with several search terms and their combinations (potato, organic, mulch). Data collections were limited to studies in which at least one organic mulch was used and potatoes were among the crops grown. Based on these criteria, we compiled 68 publications, and then collected the data extracted from them into an excel table according to different categories: sources, country, aims, mulch materials, mulching time, sowing method, pre-crop, plant/m², potato variety, plant protection, fertilizers, irrigation, tillage, yield, pests, pathogens, weeds.

Since we paid special attention to the effects of mulching on potato pests and pathogens, we supplemented the search with additional search terms on the topic (keywords: *Fusarium solani*, *Rhizoctonia solani*, *Erwinia carotovora* ssp. *carotovora*, *Pectobacterium carotovorum*, Elateridae, wireworms, Melolonthidae, white grubs, *Globodera rostochiensis*, *Globodera pallida*, potato cyst nematodes, *Ditylenchus dipsaci*, *Ditylenchus destructor*, potato tuber nematodes, *Meloidogyne* spp., root-knot nematodes).

The major pests and pathogens of potato are almost the same all over the world, while its weeds are more defined by the place of production, so we did not perform a separate search for weed species.

Since not all studies reported on the yield of potatoes, or the specific type of mulch material, or many other investigated parameters, we performed descriptive statistics instead of statistical models. Detailed information about the included publications can be found in [appendix](#).

RESULTS AND DISCUSSION

Countries

In this study, the mulching of potatoes with organic matter was investigated in a series of experiments set up in 18 countries, in different geographical and climatic areas. Most experiments were conducted in Asia in different areas of India (17), as well as in neighboring countries, in Bangladesh (5), China (5), Nepal (2), Pakistan (2), South Korea (2), Iran (1), and Indonesia (1).

Articles on the subject were also published in Africa, in Egypt (5) and South Africa (1). In Americas, there were also many experiments with potato mulching. In the USA (6), Canada (4), Brazil (1). Within Europe, articles originate from five countries, the most from the Czech Republic (7), then Germany (4), Hungary (2), Ukraine (1) and Serbia (1).

Aims

Since the experiments were carried out in different areas of the world, they focused on the problems of the given area.

The solution was sought for three main problems, the most common of which were the retention of soil moisture and increasing water use efficiency (27%), reducing soil temperature,



or minimizing heat fluctuations (16%), and suppressing weeds (15%). Another 14% of articles specifically looked into the effects of the combination of mulch and irrigation. However, what most studies mention among their goals and which receives the greatest emphasis is the study of the effect on the yield (78%).

Only 16% of the articles looked for answers to some kind of plant protection problem. The most common was the effect of mulching on the occurrence and damage of *Leptinotarsa decemlineata*. Barely 10% of the articles dealt with soil (soil loss, salt, minimum tillage), and even fewer (9%) with cultivation technology (planting depth, planting or mulching time, added fertilizations).

Mulch materials

There were 28 types of covering materials in the processed articles. In each area, they used materials which were easily available and low-cost in the given place. In half of the experiments (53%) only one type of mulch material was used. In 12% of the experiments, two types of mulch materials, and in 33% more types of mulch materials were used. The most common covering material with 84% was some kind of straw (rice straw 36%, wheat straw 12%, paddy straw 8%, maize straw 6%, barley straw 5%). Another important group of mulch materials with 16% was some kind of leaf (pine 6%, neem 3%, banana 1%, eucalyptus 1%, mahua 1%), or cut grass (16%). Compost (8%) or animal manure (5%) were moderately common mulching materials. Hay (6%) and sawdust (5%) were also included in several experiments, while wood chips and recycled paper were only used in one experiment each. Water hyacinth (14%) and a by-product of rice cultivation (rice husk, rice hull 8%) were popular covering materials in eastern countries.

Just like the type of covering material, the variety of potato was also a very important factor and could be at least as varied. A total of 44 different types of potatoes were mentioned in the articles. Their frequency was completely distributed between countries and experiments. In 85% of the experiments, only one potato variety was sown, in some other experiments, two or more. In addition, in a prominent case 6 varieties were included in one experiment. Only 10 articles did not reveal the variety of potato used in the experiments.

Most of the articles mentioned the amount of mulch material applied, but only 71% wrote the time of application, even though the differences were significant (Table 1). Mostly, the soil surface was covered after planting, after the appearance of the first shoots, or after filling. However, in some cases 30 (Chawla et al., 2009), 35 (Majumder et al., 2016) or even 50 days (Goel et al., 2020) passed before covering the soil. Even in such cases, mulching positively increased yields. On the other hand, when the covering material was worked into the soil 2–3 weeks after application, the yield-enhancing effect was no longer statistically detectable (Döring et al., 2005).

Table 1. Mulching time in the processed articles

Mulching time	Before planting	Immediately after planting	After planting (>14 day)	After planting (<14 day)	Variable date	2×	No data
Number of article	6	16	15	6	4	1	20



In the case of mulch applied before planting and left in the field until the potatoes were picked, the yield increase was always significant (Farrag et al., 2016; Kumar et al., 2018; Abd El-Wahed et al., 2020b; Pathak et al., 2021). The number of Colorado potato beetle adults were significantly higher in the plots with mulch applied at planting, but egg masses and larvae did not differ significantly. Potatoes with mulch at planting had fewer *Empoasca fabae* (Harris), and less associated plant damage (Johnson et al., 2004).

Cultivation technology

Only 25 articles made some mention of soil cultivation practices. 68% of these experiments used plowing, or tilling before sowing. In three experiments, no specific plowing was mentioned, only cultivation for the control of weeds. Also, some articles examined the effects of minimum and no tillage. The latter found that in addition to mulching, abandoning plowing reduced soil salinity (ECe) (Sarangi et al., 2020), and increased soil water use efficiency in non-irrigated conditions (Hou and Li., 2019). It effectively improved weed control (Ramírez et al., 2022) and increased yield compared to cultivated, uncovered plots (Hou and Li, 2018). It also increased soil volume density and organic matter content. In addition to all this, the cost of growing potatoes was reduced by about 27% due to zero tillage compared to traditional, intensive ridge planting (Sarangi et al., 2020).

Very few articles reported on the pre-crop or the depth of planting, even though these could be very different and greatly influence the results (Tables 2 and 3). Of the tubers planted 10, 15 or 20 cm deep, the 15 cm produced maximum marketable tuber yield (Ilyas and Ayub, 2017). Only one single article examined the effects of planting potato tubers not in the soil, but on the soil surface, under the mulch (Adamchuk et al., 2016). In this case, potato crop yield under a layer of straw was by 30–40% higher than on the control (the tubers of potatoes grown in double ridges are placed in the soil 5–20 cm deep) plots.

Plant density was also an important factor. It showed the intensity of cultivation, which had an impact on water and nutrient use, plant protection and yield. In the processed articles, this also varied widely, but the most common was the row spacing of 60 cm and the distance between plants of 20–25 cm (Table 4). In 29% of the experiments, the applied planting density was not revealed.

There was also an experiment (Chang et al., 2020) where alternating strips mulched with maize straw and bare plots with no ridges were used. Two rows of potatoes were planted in the non-mulched strips. In this case, too, the yield was significantly better than the control without mulch.

Table 2. Potato tuber planting depth in the processed articles

Planting depth	0 cm	4 cm	5–8 cm	10 cm	Variable	Na data
Number of article	1	1	3	2	2	60

Table 3. Potato pre-crops in the processed articles

Pre crop	Potato	Maize	Rice	Soybean	Other, variable	No data
Number of article	5	2	1	1	5	54



Table 4. Potato planting density based on processed articles

cm	45 × 15–20	60 × 20–25	70 × 25–30	80 × 30–45	90 × 25	Other	No data
Plant/m ²	1.5	0.8	0.6	0.4	0.4	–	–
Number of article	4	14	5	7	3	15	20

In a significant part of the experiments, in 46 articles, some kind of yield enhancer was used. This was 89% synthetic fertilizer (NPK), which was supplemented with additional nutrient source in half of the cases, mainly with organic fertilizer (76%).

Only 11% of the experiments specifically used only organic manure. In some experiments, in addition to mulching, the effect of added organic fertilizer was separately investigated, finding that it had an additional yield-increasing effect (Iriany, 2014; Kumar et al., 2018; Yagi et al., 2020). The amount applied was positively correlated with yield increase (Mukherjee, 2017).

The use of some kind of irrigation during the experiments was mentioned in 30 articles, half of which specifically examined its effects, especially with regard to crop growth. Supplementing soil mulching with irrigation was found to increase yield in many cases (Chawla et al., 2009; Farrag et al., 2016; Abd El-Wahed et al., 2020b). It was also established that, thanks to mulching, 15–30% of irrigation water could be saved without reducing the yield (Abd Allah et al., 2009; Begum and Saikia, 2014; Zayton et al., 2015; Barakat et al., 2020). Organic mulch also protected the soil from nutrient leaching caused by irrigation (Xing et al., 2012).

In addition to the investigated irrigation water quantities, the factor of whether mulch was used was important. Covered plots yielded significantly more crops than uncovered plots regardless of any amount of irrigation doses used (Burgers et Nel, 1984; Zayton et al., 2015; Oljaca et al., 2018). In non-mulched plots, irrigation had a greater effect, as it increased yield there, but in covered plots there was no difference between irrigated and non-irrigated treatments (Kar and Kumar, 2007).

Yield

93% of the articles were written about the effects of mulching on the yield. Where there was no mention of the yield, that was not the main purpose of the study. In various parts of the world, the effect of different organic mulches on potato production was 78% positive. This means a significant difference in 53% of cases compared to the control without mulch. In 10% of the experiments, significant positive effects of mulching on the potato yield could not be proved statistically. In 4%, variable results were obtained, due to precipitation conditions or other circumstances of the given year.

Examining the appropriate time for mulching, it was determined that the highest yield could be achieved with mulch applied immediately after planting (Dvořák et al., 2009). The yield could be further increased if the area is mulched not only once but twice during the growing season (Dvořák et al., 2013). It has also been established that in loose soils or with irrigation, mulching had less effect on the yield and the size distribution of the tubers (Döring et al., 2005, 2006; Xing et al., 2012). Furthermore, earlier planting of potatoes could also result in more crops (Ilyas and Ayub, 2017).



Pests

Among the processed articles, 11 of the articles mentioned any kinds of pests, which in 8 cases was *L. decemlineata*. Thanks to the mulch, the lower soil temperature correlated with the lower occurrence and damage of *L. decemlineata* (Johnson et al., 2004; Dvořák et al., 2012; Finckh et al., 2015).

A few articles compared organic mulch with black textile mulch and all found that *L. decemlineata* occurred and caused damage more frequently in the case of textile mulch (Dvořák et al., 2011, 2012, 2013, 2015). In the experiment of Stoner et al. (1996), dark-colored compost, which provides a warmer environment, also did not reduce the damage caused by *L. decemlineata* compared to straw mulch.

It was observed that in the covered plots significantly more *L. decemlineata* eggs and larvae experienced mortality. As a result, non-mulched plots suffered 2.5 times more defoliation (Brust, 1994).

One article dealt with the pests *E. fabae* (Johnson et al., 2004) and one with aphids (Saucke and Döring, 2004), and three articles dealt with *Pratylenchus penetrans* (Stoner et al., 1996; Gent et al., 1999; LaMondia et al., 1999). In all cases, mulching effectively reduced the occurrence or damage of pests.

Apart from these, not a single article dealt with the main soil-dwelling pests of potatoes such as Elateridae (wireworms), Melolonthidae (white grubs), *G. rostochiensis*, *G. pallida* (potato cyst nematodes), *D. dipsaci*, *D. destructor* (potato tuber nematodes), *Meloidogyne* spp. (Root-knot nematodes).

Pathogens

Only 12 articles dealt with potato pathogens. In three cases, *Verticillium dahliae* damage was effectively reduced by mulch (Stoner et al., 1996; Gent et al., 1999; LaMondia et al., 1999). Another three articles investigated *P. infestans* (Döring, et al., 2006; Dvořák et al., 2010; Yagi et al., 2020) and two dealt with potato virus disease (PVY) (Saucke and Döring, 2004; Döring et al., 2005), and another one discussed *Streptomyces* spp. (Majumder et al., 2016) pathogen occurrence. The pathogen *R. solani* was also dealt with in an article (Döring, et al., 2006). In all studies, the damage-reducing effect of organic mulch was reported.

There was also a study in which, without naming the specific pathogen, the authors either simply showed a reduction in the number of damaged tubers as a positive effect of mulching (Rees et al., 2002), or varying results were obtained in physiological loss and decay loss with the addition of different crop enhancers (Kumar et al., 2018). Furthermore, there was also an experiment where the use of farmyard manure increased the number of bacterial population in mulched plots (Mukherjee, 2017).

Another two very important soil-dwelling pathogens of potato, *F. solani* and *Erwinia carotovora* subsp. *carotovora* were not included in any article examining the effects of organic mulches in potatoes.

Weeds

A much larger part of the analyzed articles (29%) examined the effect of mulching on potato weed growth. Out of these 20 articles, in 15 cases the level of weeding was statistically



demonstrably reduced by mulching. In some cases, in addition to the beneficial effect of mulching, chemical weed control was not even necessary (Adamchuk et al., 2016), or the addition of herbicides did not increase the effect achieved by mulching (Barman et al., 2008; Bhullar et al., 2015). In the case of two articles, this favorable effect was not significant and in three studies other circumstances influenced the results.

CONCLUSIONS

Based on 68 articles, we could conclude that mulching is effective in suppressing weeds, helps retain soil moisture, and reduces the need for irrigation water. It protects the soil from soil loss and nutrient leaching, moderates soil temperature and temperature fluctuations, thereby creating a favorable soil environment for the cultivated potato plant.

Thus, it increases the quantity of the crop and improves its quality, regardless of the geographical location, the material of the ground cover and the type of potato. Although its effect on pests and pathogens has been less researched, based on existing results, mulching has no plant protection risks and can be an effective method for attracting natural enemies and reducing the occurrence and damage of pests.

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Appendix: Examined data of processed articles dealing with organic mulching of potatoes (sources, country, aims, mulch materials, mulching time, sowing method, pre-crop, plant/m², potato variety, fertilizers, irrigation, tillage, yield, pests, pathogens, weeds)

Sources	Abd Allah et al. (2009)	Abd El-Wahed et al. (2020)	Adamchuk et al. (2016)	Ahmed et al. (2017)	Barakat et al. (2020)
Country	Egypt	Egypt	Ukraine	Bangladesh	Egypt
Aims	yield, irrigation	yield, irrigation, mulching materials, soil moisture content, salt distribution	condition of the soil, yield	mulch materials, yield and quality	yield, irrigation
Mulch materials	rice straw	poultry manure, rice straw	straw	rice straw, water hyacinth, saw dust	rice straw
Mulching time	after earthed up tubers	before planting	after planting	-	after planting
Sowing method	-	-	surface of soil under mulch	-	-
Pre-crop	-	-	-	-	-
Plant/m ²	50 × 50 cm	70 × 30 cm	-	60 × 25 cm	70 × 25 cm
Potato variety	Spunta	Spunta	Santa	Diamant	Spunta class E
Fertilizers	fertilized	-	-	fertilized	fertilized
Irrigation	examined	examined	-	irrigated	examined
Tillage	ploughed	ploughed	ploughed	ploughed	-
Yield	positive	poultry manure mulch significantly positive	positive	not significant effect	positive
Pests	-	-	-	-	-
Pathogens	-	-	-	-	-
Weeds	controlled	-	examined	examined	-

Sources	Barman et al. (2008)	Begum et Saikia (2014)	Bharati et al. (2020)	Bhullar et al. (2015)	Brust (1994)
Country	India	India	Nepal	India	USA
Aims	weeds, yield	yield, irrigation	lack of irrigation, weeds	atrazine or straw mulch, weeds	Colorado potato beetle, natural enemies

(continued)

Continued

Sources	Barman et al. (2008)	Begum et Saikia (2014)	Bharati et al. (2020)	Bhullar et al. (2015)	Brust (1994)
Mulch materials	water hyacinth, rice straw	water hyacinth	saw dust, rice straw, rice husk	rice straw	wheat straw
Mulching time	-	after planting	-	3-4 days after planting	one week after the appearance of potato shoots
Sowing method	-	-	-	-	-
Pre-crop	-	-	-	-	soybeans
Plant/m ²	-	50 × 20 cm	60 × 20 cm	60 × 20 cm	90 × 25 cm
Potato variety	Kufri Chandramukhi	-	Desiree	Kufri Chandarmukhi	Atlantic
Fertilizers	fertilized	-	fertilized	fertilized	-
Irrigation	irrigated	examined	-	irrigated	-
Tillage	tilled	-	ploughed	ploughed	tilled
Yield	positive	significantly positive	all mulch significantly positive	significantly positive	positive
Pests	-	-	-	-	Colorado potato beetle
Pathogens	-	-	-	-	-
Weeds	examined	-	-	examined	-
Sources	Burgers et Nel (1984)	Chae-Young et al. (2010)	Chang et al. (2020)	Chawla et al. (2009)	Darvishi et al. (2019)
Country	South Africa	South Korea	China	India	Irán
Aims	irrigation, soil temperature, yield	weeds, yield	soil water storage and temperature, yield, water use efficiency	yield, irrigation	water use management, yield
Mulch materials	wheat straw	pine tree leaf, oak tree leaf, rice straw, rice hull, sawdust	maize straw	paddy straw	wood chips, straw, compost
Mulching time	-	after planting	-	50 days after planting	-
Sowing method	10 cm deep	variable	-	-	-
Pre-crop	-	-	-	-	-

(continued)





Continued

Sources	Burgers et Nel (1984)	Chae-Young et al. (2010)	Chang et al. (2020)	Chawla et al. (2009)	Darvishi et al. (2019)
Plant/m ²	91 × 23 cm	variable	variable	60 × 20 cm	28 × 15 cm
Potato variety	State-certified seed potatoes	Superior	Qingshu No. 9	Kufri Sutlej	Agria, Arinda, Sante
Fertilizers	fertilized	fertilized	fertilized	fertilized	-
Irrigation	examined	-	-	examined	examined
Tillage	-	-	tilled	-	-
Yield	significantly positive	all mulch significantly positive	significantly positive	positive	not significant effect
Pests	-	-	-	-	-
Pathogens	-	-	-	-	-
Weeds	-	examined	controlled	-	-
Sources	Döring et al. (2005)	Döring et al. (2006)	Dudás et al. (2016a)	Dudás et al. (2016b)	Duhlian et al. (2018)
Country	Germany	Germany	Hungary	Hungary	India
Aims	soil nitrate dynamics, weeds, yield, soil erosion	late blight, black scurf	carabid beetles	temperature of the top soil, soil-dwelling microarthropods.	yield
Mulch materials	chopped straw	straw	hay, leaf litter	meadow hay	rice husk
Mulching time	3-4 weeks after planting	-	-	after the appearance of potato shoots	one week after planting
Sowing method	-	-	-	-	-
Pre-crop	numerous	numerous	-	potato	-
Plant/m ²	variable	-	-	-	45 × 20 cm
Potato variety	Christa, Marabel, Rosella, Nicola	Christa, Nicola, Linda, Marabel, Rosella, Simone	-	Sárpo Mira	Thangal Alu
Fertilizers	-	-	-	-	-
Irrigation	-	-	-	-	-
Tillage	tilled	-	-	-	-

(continued)



Continued

Sources	Döring et al. (2005)	Döring et al. (2006)	Dudás et al. (2016a)	Dudás et al. (2016b)	Duhlian et al. (2018)
Yield	not significant effect	-	-	-	significantly positive
Pests	-	-	-	-	-
Pathogens	virus	<i>P. infestans</i> , <i>R. solani</i>	-	-	-
Weeds	examined	-	-	-	-
Sources	Dvořák et al. (2009)	Dvořák et al. (2013)	Dvořák et al. (2010)	Dvořák et al. (2011)	Dvořák et al. (2015)
Country	Czech Republic	Czech Republic	Czech Republic	Czech Republic	Czech Republic
Aims	weeds, yield	nitrogen status, Colorado potato beetle, yield	temperature, moisture, late blight	soil temperature, soil water potential, yield	weeds, yield
Mulch materials	chopped grass	chopped grass	chopped grass	chopped grass	chopped grass
Mulching time	after planting or after second hoeing	after planting and secondly before full germination	14 days after planting	14 days after planting	after planting or on the 14th day after planting
Sowing method	-	-	-	-	-
Pre-crop	-	-	numerous	-	-
Plant/m ²	variable	-	80 × 45 cm	80 × 45 cm	80 × 33 cm
Potato variety	Finka, Katka	-	Finka, Katka	-	Finka, Katka
Fertilizers	-	-	-	not fertilized	fertilized
Irrigation	-	-	-	-	-
Tillage	control was cultivated	control was cultivated	-	-	ploughed
Yield	significantly positive	positive	significantly positive	significantly positive	significantly positive
Pests	-	Colorado potato beetle	-	Colorado potato beetle	Colorado potato beetle
Pathogens	-	-	<i>P. infestans</i>	-	-
Weeds	examined	-	-	-	examined
Sources	Dvořák et al. (2012)	Edwards et al. (2000a)	Edwards et al. (2000b)	Farrag et al. (2016)	Finckh et al. (2015)
Country	Czech Republic	Canada	Canada	Egypt	Germany

(continued)



Continued

Sources	Dvořák et al. (2012)	Edwards et al. (2000a)	Edwards et al. (2000b)	Farrag et al. (2016)	Finckh et al. (2015)
Aims	soil temperature, water potential, weed, Colorado potato beetle, yield	soil loss	plot erosion, splash erosion	yield, irrigation	minimum tillage
Mulch materials	chopped grass	potato compost, barley straw	barley straw	rice straw	freshly cut winter pea/rye or vetch/triticale mixture
Mulching time	14 days after planting	after planting	after planting	before planting	after the first ridging
Sowing method	-	-	-	-	-
Pre-crop	numerous	-	potato	-	numerous
Plant/m ²	80 × 45 cm	-	-	-	-
Potato variety	-	Russet Burbank	Russet Burbank	Valor	-
Fertilizers	-	fertilized	-	fertilized	fertilized
Irrigation	-	-	-	examined	-
Tillage	control was cultivated	-	-	-	ploughed
Yield	significantly positive	not significant effect	-	significantly positive	variable
Pests	Colorado potato beetle	-	-	-	Colorado potato beetle
Pathogens	-	-	-	-	-
Weeds	examined	-	-	-	examined
Sources	Gent et al. (1999)	Ghimire et al. (2021)	Goel et al. (2019)	Goel et al. (2020)	Hou et Li (2018)
Country	USA	Nepal	India	India	China
Aims	<i>V. dahliae</i> , <i>P. penetrans</i> , photosynthesis, gas exchange, transpiration	yield	yield, moisture retaining ability	soil hydrothermal environment, yield	soil water and temperature, yield
Mulch materials	spent mushroom compost, rye straw	straw	whole wheat straw, whole rice straw	wheat straw, pine needle, rice straw	maize straw
Mulching time	after hilling	-	after first earthing up	30 days after planting	after planting
Sowing method	-	-	-	-	-
Pre-crop	-	-	-	-	maize

(continued)

Continued

Sources	Gent et al. (1999)	Ghimire et al. (2021)	Goel et al. (2019)	Goel et al. (2020)	Hou et Li (2018)
Plant/m ²	1 plant/microplot	60 × 20 cm	45 × 15 cm	45 × 15 cm	60 × 40 cm
Potato variety	Superior	Cardinal	Kufri Jyoti	Kufri Jyoti	Longshu No 3
Fertilizers	fertilized	fertilized	fertilized	-	fertilized
Irrigation	-	irrigated	irrigated	irrigated	not irrigated
Tillage	-	-	-	-	tillage, subsoiling, no-tillage
Yield	compost significantly positive	significantly positive	-	all mulch significantly positive	significantly positive
Pests	<i>P. penetrans</i>	-	-	-	-
Pathogens	<i>V. dahliae</i>	-	-	-	-
Weeds	-	controlled	-	-	controlled
Sources	Hou et Li (2019)	Ilyas et Ayub (2017)	Iriany (2014)	Johnson et al. (2004)	Kar et Kumar (2007)
Country	China	Pakistan	Indonesia	USA	India
Aims	temperature, moisture, yield, water use efficiency	yield, planting depths, sowing dates	yield	mulching time	yield, water use efficiency
Mulch materials	maize straw	-	straw	wheat straw	rice straw
Mulching time	-	-	-	after planting	after the first earthing up
Sowing method	10 cm deep	variable	-	-	-
Pre-crop	maize	-	-	-	-
Plant/m ²	50,000 plants/ha	70 × 25 cm	-	200 × 100 cm	45 × 15 cm
Potato variety	Longshu No 3	Kuroda	Granola	Red Pontiac	Kufri Jyoti
Fertilizers	fertilized	fertilized	fertilized	variable	fertilized
Irrigation	not irrigated	-	-	variable	examined
Tillage	no-tillage, subsoiling, plowing tillage,	ploughed	-	-	-
Yield	significantly positive	significantly positive	positive	not significant effect	positive (continued)





Continued

Sources	Hou et Li (2019)	Ilyas et Ayub (2017)	Iriany (2014)	Johnson et al. (2004)	Kar et Kumar (2007)
Pests	-	-	-	Colorado potato beetle, <i>Empoasca fabae</i>	-
Pathogens	-	-	-	-	-
Weeds	-	-	-	examined	-
Sources	Král et al. (2019)	Kumar et al. (2018)	LaMondia et al. (1999)	Li et al. (2018)	Mahmood et al. (2002)
Country	Czech Republic	India	USA	China	Pakistan
Aims	yield	yield, quality, mulches level, manures and bio-fertilizer levels	potato early dying of amending mineral soil	yield, water use efficiency, review	yield
Mulch materials	wheat straw, commercial compost	grass	spent mushroom compost, rye straw	straw mulch	grass
Mulching time	variable	before the emergence of weeds and crop	-	-	one week after planting
Sowing method	-	-	5-8 cm deep	-	-
Pre-crop	-	-	-	-	-
Plant/m ²	80 × 30 cm	60 × 20 cm	1 plant/microplot	-	-
Potato variety	Dicolora	Kufri Bahar	Superior	-	Cardinal
Fertilizers	fertilized	fertilized	fertilized	fertilized	fertilized
Irrigation	-	irrigated	-	-	-
Tillage	-	-	-	-	-
Yield	all mulch significantly positive	significantly positive	compost significantly positive	positive	significantly positive
Pests	-	-	<i>P. penetrans</i>	-	-
Pathogens	-	decay loss	<i>V. dahliae</i>	-	-
Weeds	-	examined	-	-	-
Sources	Majumder et al. (2016)	Manrique (1995)	Mukherjee (2017)	Nowroz et al. (2021)	Oljaca et al. (2018)
Country	Bangladesh	Honolulu	India	Bangladesh	Serbia (continued)

Continued

Sources	Majumder et al. (2016)	Manrique (1995)	Mukherjee (2017)	Nowroz et al. (2021)	Oljaca et al. (2018)
Aims	soil temperature, soil water potential, yield	efficient mulching techniques, review	fertilizers	yield, potato varieties, mulch materials	mulch materials, cultivar, yield
Mulch materials	water hyacinth, rice straw	leaves (Setaria, banana, Neem, maize) sugarcane bagasse, dried grass, barley or rice straw	farm yard manure, rice straw, stubble mulch (grasses and twig etc.).	water hyacinth, rice straw, rice husk	straw
Mulching time	35 days after planting	at or after planting	after planting	before planting	after planting
Sowing method	-	-	-	-	-
Pre-crop	-	-	-	-	-
Plant/m ²	60 × 25 cm	-	60 × 20 cm	-	80 × 30 cm
Potato variety	Diamant	-	Kufri Jyoti	Lady rosetta, Asterix, Diamant, Courage, Bari	Carrera, Laura, Agria
Fertilizers	fertilized	fertilized	fertilized	fertilized	-
Irrigation	irrigated	irrigated	-	-	irrigated
Tillage	-	-	-	-	-
Yield	all mulch significantly positive	positive	all mulch significantly positive	significantly positive	positive
Pests	-	-	-	-	-
Pathogens	scab	-	bacterial population	-	-
Weeds	examined	examined	-	-	-
Sources	Panging et al. (2022)	Pathak et al. (2021)	Rahaman et al. (2004)	Ramírez et al. (2022)	Razzaque et Ali (2009)
Country	India	India	Bangladesh	Asia	Bangladesh
Aims	planting date, rain water use efficiency	weed management, yield, nutrients uptake, soil health	yield	zero/minimum-tillage, review	potato varieties, mulching materials, no tillage, yield
Mulch materials	water hyacinth	Eucalyptus leaf, Mahua leaf, Rice straw, Water hyacinth, Neem leaf	rice straw, water hyacinth, wastage of rice straw	rice straw, peddy straw, wheat straw, pine-needle, reed the grass	rice straw, water hyacinth
Mulching time	3 dates of planting	before planting	after planting	-	after planting (continued)





Continued

Sources	Panging et al. (2022)	Pathak et al. (2021)	Rahaman et al. (2004)	Ramírez et al. (2022)	Razzaque et Ali (2009)
Sowing method	-	-	-	-	-
Pre-crop	-	-	-	-	-
Plant/m ²	-	60 × 20 cm.	-	-	60 × 25 cm
Potato variety	Kufri Jyoti	Kufri Neelkanth	Diamont	-	Heera, Dhera, Diamant, Chamak, Cardinal
Fertilizers	-	fertilized	fertilized	-	fertilized
Irrigation	-	-	-	-	irrigated
Tillage	-	-	-	zero or minimum-tillage	control or zero tillage
Yield	significantly positive	significantly positive	all mulch significantly positive	positive	positive
Pests	-	-	-	-	-
Pathogens	-	-	-	-	-
Weeds	-	examined	-	examined	controlled
Sources	Rees et al. (2002)	Ri-Xian et al. (2002)	Sarangi et al. (2020)	Saucke et Döring (2004)	Sekhon et al. (2020)
Country	Canada	South Korea	India	Germany	India
Aims	various hay mulch application rates, soil loss, yield	soil environments, yield	Sustainable intensification, soil moisture, soil health, profitability	vectors and virus incidence, presprouting	irrigation water quality, soil temperature, water use efficiency, yield
Mulch materials	hay	recycled paper	paddy straw	wheat straw	rice straw
Mulching time	after potato harvest	after planting	-	12 days after crop emergence	after planting
Sowing method	-	-	4 cm deep	-	5-7 cm deep
Pre-crop	potato	-	rice	-	-
Plant/m ²	-	35 × 25 cm	30 × 15 cm	75 × 33 cm	60 × 20 cm
Potato variety	Russet Burbank	Daeji	Kufri Pukhraj	Christa, Nicola	Kufri Bahar
Fertilizers	fertilized	fertilized	fertilized	-	fertilized

(continued)

Continued

Sources	Rees et al. (2002)	Ri-Xian et al. (2002)	Sarangi et al. (2020)	Saucke et Döring (2004)	Sekhon et al. (2020)
Irrigation	–	–	irrigated	–	examined
Tillage	tilled	–	control or zero tillage	–	–
Yield	all mulch significantly positive	significantly positive	significantly positive	not significant effect	positive
Pests	–	–	–	aphid	–
Pathogens	disease	–	–	PVY	–
Weeds	–	examined	–	controlled	–
Sources	Shafiq et Kaur (2021)	Shukla et al. (2020)	Stoner et al. (1996)	Xing et al. (2012)	Yagi et al. (2020)
Country	India	India	USA	Canada	Brazil
Aims	yield, weeds	yield, quality, irrigation	soil amendment, yield, Colorado potato beetle	yield	yield, fertilizers, poultry litter
Mulch materials	paddy straw	paddy straw	straw, spent mushroom compost, or both	hay	chopped Elephant grass
Mulching time	–	–	after planting	one week after plant emergence	after hilling
Sowing method	–	–	–	–	–
Pre-crop	–	–	potato	potato	–
Plant/m ²	60 × 20 cm	60 × 20 cm	90 × 25 cm	–	80 × 30 cm
Potato variety	Kufri Pukhraj	Kufri Arun	Superior	Shepody variety elite III	IPR Cris cultivar
Fertilizers	fertilized	fertilized	fertilized	fertilized	fertilized
Irrigation	irrigated	examined	irrigated	examined	–
Tillage	–	ploughed	–	–	ploughed
Yield	positive	significantly positive	variable	variable	not significant effect

(continued)





Continued

Sources	Shafiq et Kaur (2021)	Shukla et al. (2020)	Stoner et al. (1996)	Xing et al. (2012)	Yagi et al. (2020)
Pests	-	-	Colorado potato beetle	-	-
Pathogens	-	-	<i>V. dahliae</i>	-	<i>P. infestans</i>
Weeds	examined	-	-	-	controlled
Sources	Wang et al. (2019)	Zahed et al. (2021)	Zayton et al. (2015)		
Country	China	India	Egypt		
Aims	yield, NUE, review	mulch material, yield	yield, water use efficiency		
Mulch materials	straw mulch	pine needle, rice straw, farmyard manure	rice straw		
Mulching time	-	-	after planting		
Sowing method	-	-	-		
Pre-crop	-	-	-		
Plant/m ²	-	60 × 20 cm	4-4.2 plant/m ²		
Potato variety	-	Shalimar Potato-1	Spunta		
Fertilizers	fertilized	fertilized	-		
Irrigation	-	-	irrigated		
Tillage	-	ploughed	-		
Yield	significantly positive	rice straw significantly positive	positive		
Pests	-	-	-		
Pathogens	-	-	-		
Weeds	-	examined	examined		