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Usha Parmar
Ph.D., Research Scholar Horticulture, Department of Horticulture CoA, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, Madhya Pradesh, India

Dr. NK Gupta
Head of the Department of Horticulture CoA, Indore, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, Madhya Pradesh, India

Dr. Swati Barche
Professor, Horticulture, Department of Horticulture CoA, Indore, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, Madhya Pradesh, India

Dr. IS Naruka
Head of the Department of Horticulture CoA, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, Madhya Pradesh, India

IK Binepal
Ph.D., Research Scholar Horticulture, Department of Horticulture CoA, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India

Corresponding Author:
Usha Parmar
Ph.D., Research Scholar Horticulture, Department of Horticulture CoA, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, Madhya Pradesh, India

Effect of various types of mulching on growth characters of potato (*Solanum tuberosum* L.)

Usha Parmar, Dr. NK Gupta, Dr. Swati Barche, Dr. IS Naruka and IK Binepal

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Abstract
To find out a suitable mulch material for potato production is an important issue for the farmers. The aim of the present study was to evaluate the effect of inorganic and organic mulches on growth, yield and quality of potato cv. Kufri Himalini under drip irrigation system in the Department of Horticulture, at the research Farm, College of Agriculture, Indore (M.P.) during the rabi season of 2020-21 and 2021-22. A field experiment was conducted in the Randomized Block Design with three replication and comprised of total twenty treatments. The results concluded that removal of black polyethylene mulch (25 µ) at 60 DAP was found most effective and more beneficial than rest of the treatment for all the characters of potato while the minimum values of the same was found under control (without mulch) treatment. All the mulches have significant influence on the growth characters *viz*. Plant height, Number of branches. The results revealed that in the first year 2020-21 the maximum plant height at 45, 60, 75 DAP and at harvest was recorded 39.07, 51.03, 51.67 and 49.04 respectively in the treatment T_2 (removal of black mulch 25 micron at 60 DAP) while in the second year 2021-22 the results were 37.03, 49.43, 49.53 and 48.20 at the same days of interval respectively. In pooled year the values were 38.05, 50.23, 50.60 and 48.62 at 45, 60, 75 DAP and at harvest respectively was found in the treatment T_2 (removal of black mulch 25 micron at 60 DAP) respectively over rest of the treatment. Significantly also maximum number of branches. The results revealed that in the first year 2020-21 the maximum number of branches at 45, 60, 75 DAP and at harvest stage was recorded 20.67, 21.53, 21.79 and 20.73 respectively in the treatment T_2 – (removal of black mulch 25 micron at 60 DAP). These treatments were statistically at par with each other while in the second year 2021-22 the results were 19.67, 21.20, 21.53 and 20.04 at the same days of interval stage respectively. In pooled year the values were 20.17, 21.37, 21.66 and 20.39 at 45, 60, 75 DAP and at harvest stage respectively also obtained in the same treatment over the non mulch treatment.

Keywords: Potato, organic mulching, inorganic mulching

Introduction
Potato (*Solanum tuberosum* L.) is an annual, herbaceous, cool-season, tuber crop of solanaceae family that contains all the essential food ingredients required for maintaining proper health of human beings. The widely cultivated potato is tetraploid with 2n=48. It is popularly known as 'The King of Vegetables', and it ranks fourth largest global food crop following rice, wheat and maize respectively. India is the second largest producer of potato in the world after china. It is the one of the most important food crops both in developed as well as in developing countries as food, feed, raw material for producing starch. Potato is a highly nutritious, easily digestible, wholesome food containing carbohydrates, proteins, minerals, vitamins and high quality dietary fibre. A potato tuber contains 80 percent water and 20 percent dry matter consisting of 14 percent starch, 2 percent sugar, 2 percent protein, 1 percent minerals, 0.6 percent fibre, 0.1 percent fat, and vitamins B and C in adequate amount. (Gangwar *et al.*, 2017) [11].

Mulching plays a very important role in the potato production. Mulch is a preventive layer covering the surface of the soil and it contains organic and inorganic materials. The word mulching was derived from the German word Mulsch which means soft and beginning to decay. Mulching has numerous advantages, it reduces labour required in potato cultivation for weed control. It also reduces the requirement for tillage and the use of weed-control chemicals for weed control.

It does not harm the crop and can be either organic or inorganic in nature. Mulching is done to improve the soil structure, as it conserves the soil moisture by slowing the evaporation rate, regulates the soil temperature and provides a more unified appearance to the field.

Organic mulches are those natural origin materials which can decompose naturally & serve as source of plant nutrients such as straw, plant leaves & compost etc. the main advantage of organic mulches nutrient supply such as increased amounts of available soil P_2O_5 and K_2O. In inorganic mulching, by the use of plastic mulch, soil properties like soil temperature, soil moisture content, bulk density, aggregate stability and nutrient availability is improved which in turn improves plant growth and yield as it modifies the soil microclimate.

Materials and Methods

The present experiment was laid out in the field of the Research Farm of Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Department of Horticulture, College of Agriculture Indore, during rabi season of the year 2020-21 and 2021-22. Indore is situated in malwa plateau region in the western part of the state of Madhya Pradesh at an altitude of 555.5 meters above mean sea level (MSL). It is located at latitude 22º 43 N and longitude of 75º66 E. It has subtropical climate having a temperature range of 21 ºC to 45 ºC and 6 ºC to 31ºC in summer and winter seasons, respectively. The topography of the experimental site was almost uniform with an adequate surface drainage. The soil of the experimental field has been grouped under medium black clayey soil (Vertisols) belonging to Kamliakhedi series, which is a member of fine, smectitic, hyperthermic family of Vertic, Ustochrepts.

The physico-chemical analysis of soil showed that the soil of experimental site was predominantly clayey in texture. The organic carbon content (0.26%) and available nitrogen (216.0 kg ha^{-1}) content were low. The available phosphorus (12.2 kg ha^{-1}) and potash (420 kg ha^{-1}) were medium and high respectively. The soil was slightly alkaline in nature with 7.6 pH. Electrical conductivity (0.35 dS m^{-1}) of soil was found normal.

T_1 - Removal of black mulch 25 micron at 45 DAP, T_2 - Removal of black mulch 25 micron at 60 DAP, T_3 - Without removal black mulch 25 micron, T_4 -Removal of white mulch 25 micron at 45 DAP, T_5 - Removal of white mulch 25 micron at 60 DAP, T_6 - Without removal white mulch 25 micron, T_7 - Removal of silver mulch 25 micron at 45 DAP, T_8 - Removal of silver mulch 25 micron at 60 DAP, T_9 - Without removal silver mulch 25 micron, T_{10} - Mulching with Paddy Straw 2.5 cm, T_{11} - Mulching with Paddy Straw 5.0 cm, T_{12} - Mulching with Soyabean Straw 2.5 cm, T_{13} - Mulching with Soyabean Straw 5.0 cm, T_{14} - Mulching with Gram Straw 5.0 cm, T_{15} - Mulching with Gram Straw 2.5 cm, T_{16} - Mulching with F.Y.M 5.0 cm, T_{17} - Mulching with F.Y.M 2.5 cm, T_{18} -Mulching with Vermicompost 2.5 cm, T_{19} -Mulching with Vermicompost 5.0 cm, T_{20} -Control (Non-mulched).

Plant height (cm)

The data clearly indicated that the plant height of potato responded significantly due to different treatments at all the growth stages under present studies. Plant height was recorded at 45, 60, 75 DAP and at harvest. The plant height of potato plant as influenced by different treatments is given in Table NO. 1 and graphically presented in Fig. (1, 2, 3). The data presented in the Table NO. 1 suggested that the treatments had a significant effect on plant height at 45, 60, 75 DAP and at harvest stage. The results revealed that in the first year 2020-21 the maximum plant height at 45, 60, 75 DAP and at harvest was recorded 39.07, 51.03, 51.67 and 49.04 respectively in the treatment T_2 (removal of black mulch 25 micron at 60 DAP) while in the second year 2021-22 the results were 37.03, 49.43, 49.53 and 48.20 at the same days interval respectively. In pooled year the value were 38.05, 50.23, 50.60 and 48.62 at 45, 60, 75 DAP and at harvest respectively was found in the treatment T_2 (removal of black mulch 25 micron at 60 DAP) which was superior to other treatments in the study which was followed by the treatment T_8 (removal of silver mulch 25 micron at 60 DAP) valued (37.83, 50.40, 51.47 and 48.67) at 45, 60, 75 DAP and at harvest respectively in the first year 2020-21, in the second year 2021-22 valued (36.27, 49.00, 49.28 and 47.83) at 45, 60, 75 DAP and at harvest respectively and in pooled year valued (37.05,49.70,50.37 and 48.25) same days of interval respectively and in the treatment T_5 (removal of white mulch 25 micron at 60 DAP)valued (37.33, 50.33, 51.07 and 48.41) at 45, 60, 75 DAP and at harvest respectively in the first year 2020- 21, in the second year 2021-22 valued (35.67, 48.80, 49.20 and 47.78) at 45, 60, 75 DAP and at harvest respectively and in pooled year (36.50 at 45, 60, 75 DAP and at harvest respectively and in pooled year (36.50, 49.57,50.13 and 48.10) at 45, 60, 75 DAP and at harvest respectively. These treatments were statistically at par with each other in different interval whereas minimum plant height valued (31.33, 39.33, 45.43 and 44.87) at 45, 60, 75 DAP and at harvest respectively in the first year 2020-21, (32.17, 38.67, 42.11 and 41.03) in at 45, 60, 75 DAP and at harvest respectively in the second year 2021-22 and in pooled year the valued (31.75, 39.00, 43.77 and 42.95) at 45, 60, 75 DAP and at harvest respectively was recorded in the treatment T_{20} (control) at different interval 45, 60, 75 DAP and at harvest stage respectively.

Fig 1: View of the experimental field

Number of branches per plant

The number of branches per plant of different treatment is given in the Table NO. 2. The results were graphically presented in Fig. (4,5,6 and 7). The data presented in the Table NO. 2 suggested that the treatments had a significant effect on number of branches at 45, 60, 75 DAP and at harvest stage. The results revealed that in the first year 2020-21 the maximum number of branches at 45, 60, 75 DAP and at harvest stage was recorded 20.67, 21.53, 21.79 and 20.73 respectively in the treatment T_2 –(removal of black

mulch 25 micron at 60 DAP). These treatments were statistically at par with each other while in the second year 2021-22 the results were 19.67, 21.20, 21.53 and 20.04 at the same days of interval stage respectively. In pooled year the value were 20.17, 21.37, 21.66 and 20.39 at 45, 60, 75 DAP and at harvest stage respectively also obtained in the same treatment which was superior to other treatments in the study which was followed by T_8 (removal of silver mulch 25 micron at 60 DAP) valued (19.67, 20.87, 21.24 and 20.70) at 45, 60, 75 DAP and at harvest stage respectively in the first year 2020-21, in the second year 2021-22 valued (19.40, 19.85, 20.48 and 20.03)at 45, 60, 75 DAP and at harvest stage respectively and in pooled year (19.53, 20.36 , 20.86 and 20.37) at 45, 60, 75 DAP and at harvest stage respectively and T_5 (removal of white mulch 25valued (19.53, 20.63, 20.93 and 20.07) at 45, 60, 75 DAP and at harvest stage respectively in the year first year 2020-21, in second the year 2021-22 (19.27,19.82, 20.24 and 19.93) at 45, 60, 75 DAP and at harvest stage respectively, in pooled year (19.40, 20.23, 20.59 and 20.00) at 45, 60,75 DAP and at harvest stage respectively. These treatments were statistically at par with each other while the minimum value of the same character was associated with in the treatment T_{20} (Control) valued (14.23,16.27, 17.07 and 16.37) at 45, 60, 75 DAP and at harvest stage respectively in the first year 2020-21, in the second year 2021-22 valued (13.67, 14.51, 16.54 and 16.27) at 45, 60, 75 DAP and at harvest stage respectively and in pooled year (13.95, 15.39,16.80 and 16.32) the value were recorded in the treatment T_{20} (control) at different interval at 45, 60, 75 DAP and at harvest stage respectively.

Table 1: Plant height (cm) of potato in treatments at different plant growth stages.

	Treatment	Plant height (cm) 45DAP			Plant height (cm) 60 DAP			Plant height (cm) 75 DAP			Plant height (cm) at harvest		
		1st year	2nd year	Pooled	1st year	2nd year	Pooled	1st year	2nd Year	Pooled	1st year	2nd year	Pooled
T_1	Removal of black mulch 25 micron at 45 DAP	36.50	35.60	36.05	50.17	48.33	49.25	50.83	48.75	49.79	47.93	47.47	47.70
T_2	Removal of black mulch 25 micron at 60 DAP	39.07	37.03	38.05	51.03	49.43	50.23	51.67	49.53	50.60	49.04	48.20	48.62
T_3	Without removal black mulch 25 micron	36.33	35.62	35.98	50.07	48.67	49.37	50.33	48.86	49.60	47.87	47.67	47.77
T_4	Removal of white mulch 25 micron at 45 DAP	35.17	34.33	34.75	49.07	47.67	48.37	49.80	47.93	48.87	47.67	46.60	47.13
T_5	Removal of white mulch 25 micron at 60 DAP	37.33	35.67	36.50	50.33	48.80	49.57	51.07	49.20	50.13	48.41	47.78	48.10
T_6	Without removal white mulch 25 micron	34.83	35.07	34.95	49.03	47.81	48.42	49.67	48.33	49.00	47.67	46.85	47.26
T_7	Removal of silver mulch 25 micron at 45 DAP	36.17	35.20	35.68	49.33	48.07	48.70	50.27	48.44	49.35	47.80	46.93	47.37
T_8	Removal of silver mulch 25 micron at 60 DAP	37.83	36.27	37.05	50.40	49.00	49.70	51.47	49.28	50.37	48.67	47.83	48.25
T_9	Without removal silver mulch 25 micron	35.33	35.40	35.37	49.33	48.32	48.83	49.93	48.47	49.20	47.74	47.44	47.59
T_{10}	Mulching with Paddy Straw 2.5 cm	34.67	34.33	34.50	48.67	47.60	48.13	49.33	47.85	48.59	47.63	46.58	47.11
T_{11}	Mulching with Paddy Straw 5.0 cm	36.77	35.63	36.20	50.20	48.67	49.44	50.93	49.13	50.03	48.08	47.71	47.89
T_{12}	Mulching with Soyabean Straw 2.5cm	33.93	33.87	33.90	48.33	46.33	47.33	49.07	47.33	48.20	47.33	45.57	46.45
T_{13}	Mulching with Soyabean Straw 5.0 cm	34.13	33.73	33.93	48.43	46.00	47.22	49.08	46.83	47.96	47.40	45.47	46.43
T_{14}	Mulching with Gram Straw 5.0cm	34.50	34.01	34.26	48.67	46.67	47.67	49.13	47.40	48.27	47.60	45.75	46.67
T_{15}	Mulching with Gram Straw 2.5 cm	34.27	34.27	34.27	48.47	47.16	47.81	49.13	47.75	48.44	47.47	46.07	46.77
T_{16}	Mulching with F.Y.M 5.0 cm	33.33	33.70	33.52	47.73	44.00	45.87	48.44	46.80	47.62	46.47	45.41	45.94
T_{17}	Mulching with F.Y.M 2.5 cm	32.87	33.33	33.10	47.67	43.47	45.57	48.33	46.41	47.37	45.27	44.83	45.05
T_{18}	Mulching with Vermicompost 2.5 cm	33.87	33.67	33.77	48.00	43.67	45.83	48.87	46.41	47.64	47.33	45.33	46.33
T_{19}	Mulching with Vermicompost 5.0 cm	33.40	32.70	33.05	47.77	42.78	45.27	48.80	44.07	46.43	47.07	43.40	45.23
T_{20}	Control (Non-mulched)	31.33	32.17	31.75	39.33	38.67	39.00	45.43	42.11	43.77	44.87	41.03	42.95
	S.Em ±	0.87	1.08	0.69	0.80	0.83	0.58	0.53	0.62	0.41	0.66	0.63	0.46
	C.D. at 5% level	2.45	3.05	1.95	2.27	2.35	1.63	1.50	1.76	1.15	1.86	1.79	1.29

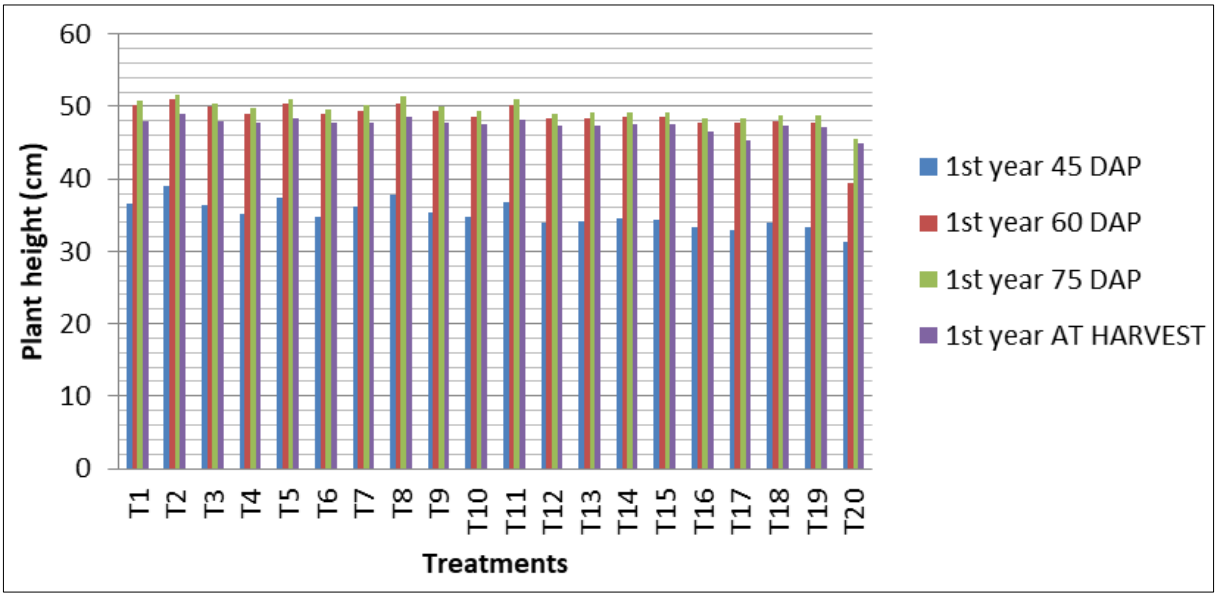

Fig 1: Plant height (cm) of potato in treatments at different plant growth stages in the year 2020-21.

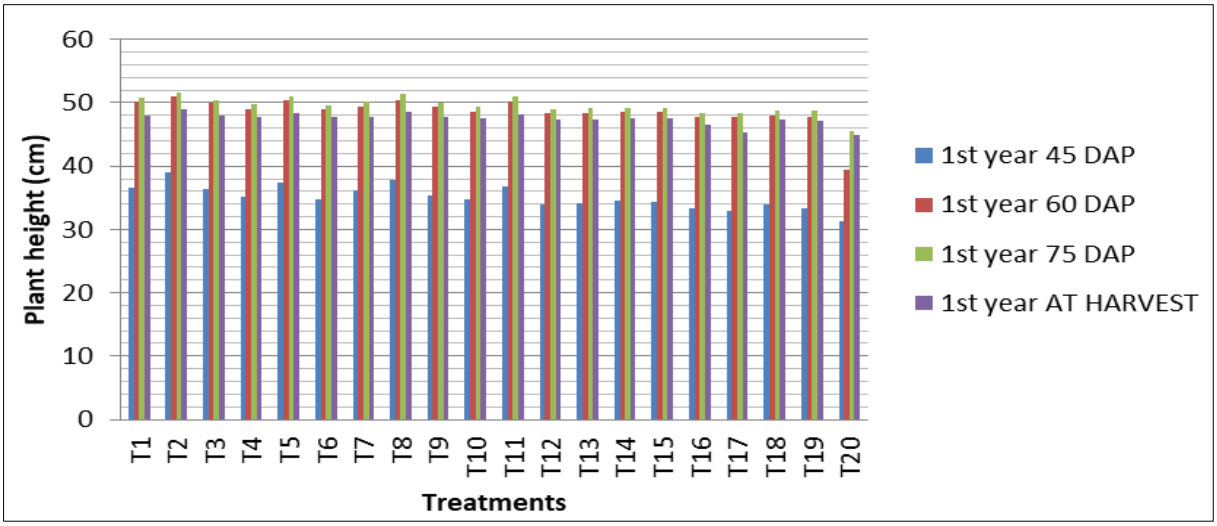

Fig 2: Plant height (cm) of potato in treatments at different plant growth stages in the year 2021-22.

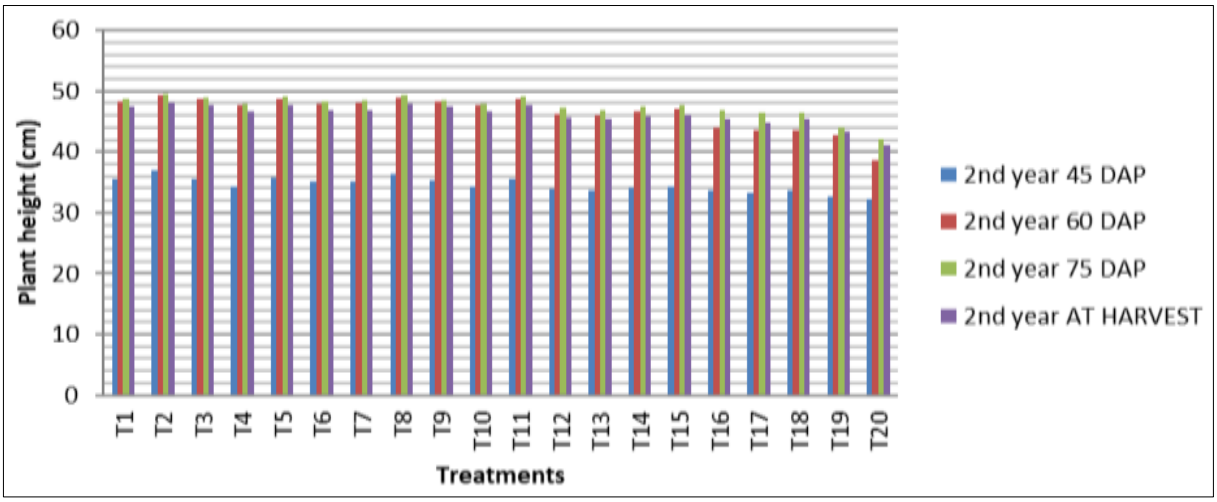

Fig 3: Plant height (cm) of potato in treatments at different plant growth stages in the pooled year.

Table 2: Number of branches/plant of potato as influenced by various treatments in different plant growth stages.

	Treatment	Number of branches 45 DAP			Number of branches 60 DAP			Number of branches 75 DAP			Number of branches at harvest		
		1st Year	2nd Year	Pooled	1st year	2nd year	Pooled	1st year	2nd year	Pooled	1st year	2nd year	Pooled
T_1	Removal of black mulch 25 micron at 45 DAP	19.23	18.45	18.84	20.37	19.57	19.97	20.80	19.94	20.37	19.67	19.53	19.60
T_2	Removal of black mulch 25 micron at 60 DAP	20.67	19.67	20.17	21.53	21.20	21.37	21.79	21.53	21.66	20.73	20.04	20.39
T_3	Without removal black mulch 25 micron	19.20	18.53	18.87	20.30	19.60	19.95	20.79	19.96	20.38	19.40	19.67	19.53
T_4	Removal of white mulch 25 micron at 45 DAP	18.67	17.27	17.97	19.60	18.89	19.25	20.53	19.67	20.10	19.33	19.13	19.23
T_5	Removal of white mulch 25 micron at 60 DAP	19.53	19.27	19.40	20.63	19.82	20.23	20.93	20.24	20.59	20.07	19.93	20.00
T_6	Without removal white mulch 25 micron	18.67	17.82	18.24	19.57	18.97	19.27	20.39	19.76	20.08	19.20	19.18	19.19
T_7	Removal of silver mulch 25 micron at 45 DAP	19.10	18.20	18.65	20.27	18.98	19.62	20.71	19.77	20.24	19.38	19.37	19.38
T_8	Removal of silver mulch 25 micron at 60 DAP	19.67	19.40	19.53	20.87	19.85	20.36	21.24	20.48	20.86	20.70	20.03	20.37
T_9	Without removal silver mulch 25 micron	18.87	18.31	18.59	19.62	19.17	19.39	20.58	19.87	20.22	19.37	19.43	19.40
T_{10}	Mulching with Paddy Straw 2.5 cm	18.33	16.93	17.63	19.33	18.74	19.04	19.88	19.61	19.74	19.13	18.97	19.05
T_{11}	Mulching with Paddy Straw 5.0 cm	19.33	18.87	19.10	20.53	19.74	20.14	20.87	20.07	20.47	20.03	19.77	19.90
T_{12}	Mulching withSoyabeanStraw 2.5.cm	17.83	16.73	17.28	19.11	18.27	18.69	19.33	18.88	19.11	18.37	18.57	18.47
T_{13}	Mulching withSoyabean Straw 5.0 cm	18.13	16.60	17.37	19.20	18.11	18.66	19.53	18.78	19.16	18.67	18.53	18.60
T_{14}	Mulching with Gram Straw 5.0cm	18.33	16.82	17.58	19.27	18.53	18.90	19.65	19.07	19.36	18.97	18.93	18.95
T_{15}	Mulching with Gram Straw 2.5 cm	18.27	16.87	17.57	19.21	18.63	18.92	19.54	19.23	19.38	18.97	18.94	18.95
T_{16}	Mulching with F.Y.M 5.0 cm	17.63	16.56	17.10	18.53	17.97	18.25	18.77	18.63	18.70	18.07	18.43	18.25
T_{17}	Mulching with F.Y.M 2.5 cm	17.33	16.23	16.78	18.40	17.66	18.03	18.60	18.10	18.35	17.97	18.00	17.98
T_{18}	Mulching withVermicompost 2.5 cm	17.67	16.48	17.08	18.70	17.96	18.33	18.96	18.40	18.68	18.23	18.03	18.13
T_{19}	Mulching withVermicompost 5.0 cm	17.67	16.15	16.91	18.67	16.93	17.80	18.87	17.97	18.42	18.20	17.60	17.90
T_{20}	Control (Non-mulched)	14.23	13.67	13.95	16.27	14.51	15.39	17.07	16.54	16.80	16.37	16.27	16.32
	S.Em ±	0.48	0.73	0.44	0.44	0.50	0.33	0.43	0.69	0.41	0.52	0.46	0.35
	C.D. at 5%	1.36	2.07	1.23	1.24	1.42	0.94	1.23	1.94	1.14	1.47	1.29	0.97

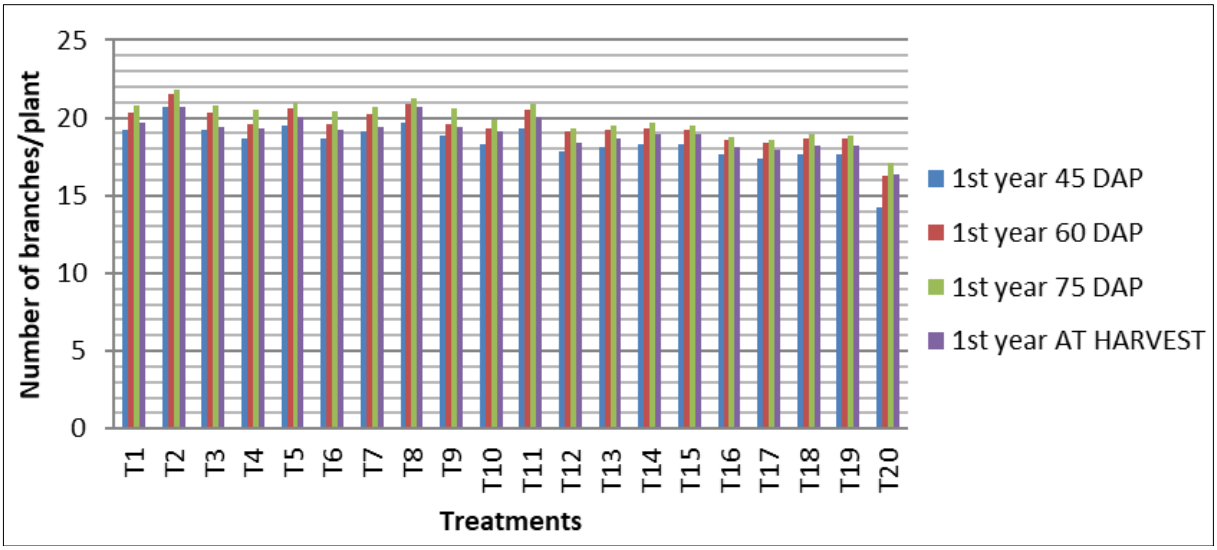

Fig 4: Number of branches per plant of potato as influenced by various treatments in different plant growth stages in the year 2020-21.

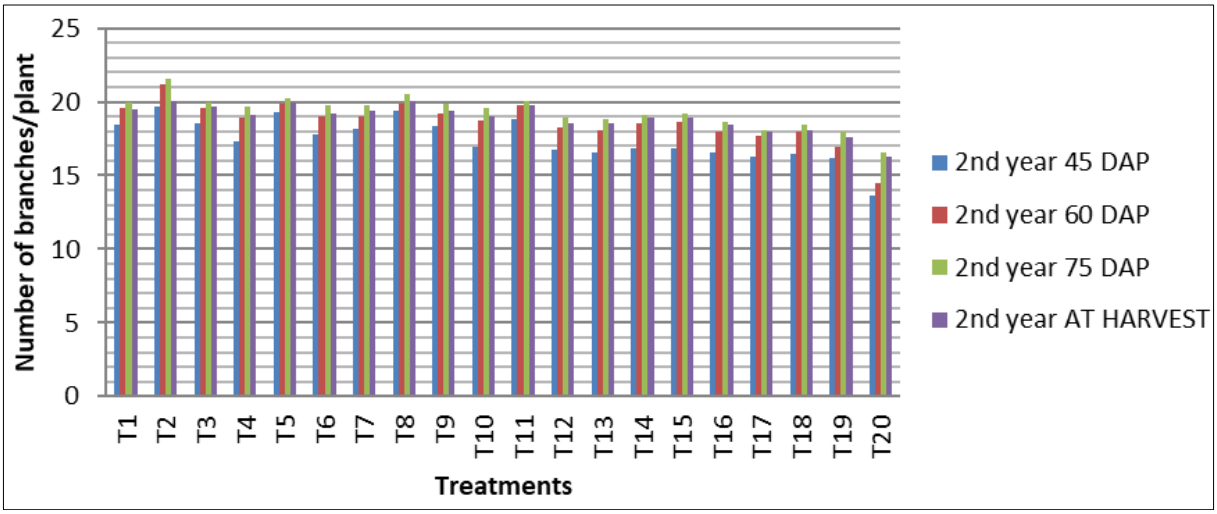

Fig 5: Number of branches per plant of potato as influenced by various treatments in different plant growth stages in the year 2021-22.

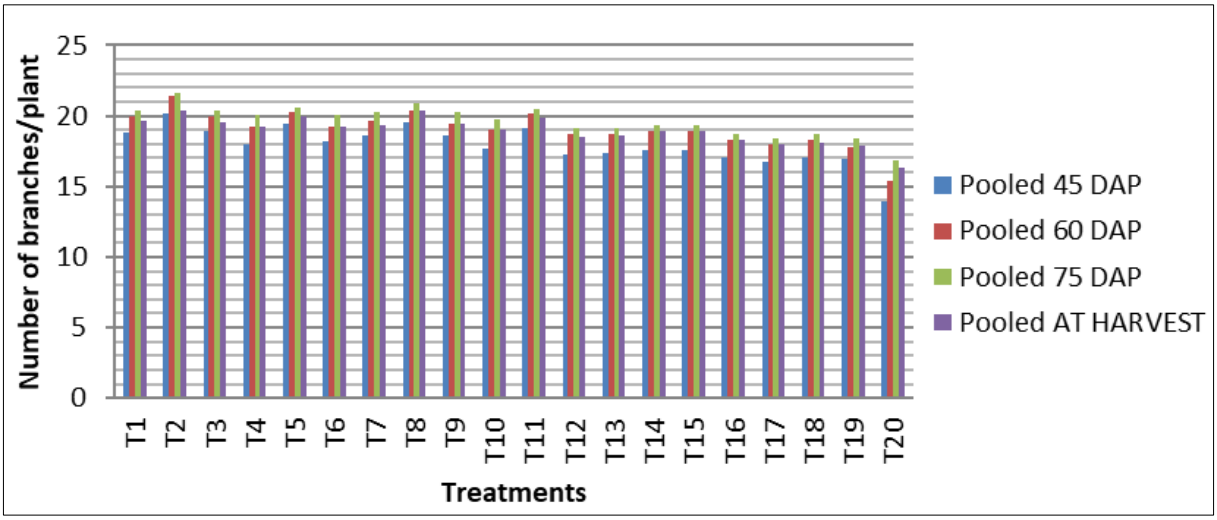

Fig 6: Number of branches per plant of potato as influenced by various treatments in different plant growth stages in the year 2021-22.

Discussion

Various treatments showed significant variation in morphological attributes *viz*., plant height, number of branches, number of leaves/plant, leaf area, leaf area index, fresh and dry weight of leaves were recorded at different intervals. It is obvious clearly indicated that there was significant variation due to various treatments at all the stages of growth. Significantly maximum plant height was recorded in treatment T_2 (removal of black mulch 25 micron at 60 DAP) in the both the year & pooled at 45, 60, 75 DAP and at harvest whereas minimum plant height was recorded in T_{20} (control) at different interval and at harvest stage in

both the year & pooled at 45, 60, 75 DAP and at harvest. All the treatment significantly increased the plant height over control (Non mulched) because it had reduced the weed population without adverse effect on the crop. The increased plant height in mulched plants was possibly due to better availability of soil moisture and optimum soil temperature provided by the mulches. Changes in the plant height of have been observed by using different mulches and plastic mulch increased the plant height than other mulches.

The significantly maximum number of branches was recorded in treatment T_2 (Removal of black mulch 25 micron at 60 DAP) in the both the year & pooled at 45, 60, 75 DAP and at harvest while minimum number of branches was recorded in the treatment T_{20} (control) at different interval and at harvest stage in both the year & pooled at 45, 60, 75 DAP and at harvest. Maximum number of branches and leaves per plant among the mulches in the experiment may be due to less weed crop competition.

Conclusion

On the basis of present investigation, it could be concluded that among three different mulching material, black polyethylene sheet found to be significantly superior for plant height, number of branches, as compared to other mulching treatment. The treatment T_2 (Removal of black mulch 25 micron at 60 DAP) recorded maximum growth under Kufri Himalini. Mulching in the form of cover crops and practicing reduce tillage have some ecological advantages over conventional land preparation tasks such as ploughing and disking the entire field as they are generally less disrupted to the soil environment.

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