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Effect of planting date and mulching on maize sugar-75 (*Zea mays* L.) yield in Tarai region of Uttarakhand

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Abstract

The study was conducted at Norman E. Borlaug Crop Research Centre of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, U.S Nagar (Uttarakhand) during *Kharif* seasons of 2018. Three planting date viz. 11th July, 23rd July and 21st August 2018 and three types of mulching material with one control treatment viz. Dhaincha mulch, Green weed mulch and Plastic mulch was studied during the experimental period. Hybrid maize variety Maize Sugar 75 was used for the study. The experiment was laid out in 2- factorial Randomized design with three number of replication having net plot size 5m x 3m. The various ancillary observations on the growth were periodically recorded along with post-harvest studies to evaluate the treatment effects. Green cob yield and grain yield was maximum for 11th July sowing and lowest for 21st August sown maize sugar 75.

Keywords: Maize sugar 75, sweet corn, planting date, organic & inorganic mulch

1. Introduction

Corn (*Zea mays* L.) is grown almost all over the world in different agro-climatic conditions and in different seasons and it is one of the most important cereals for both human and animal consumption. Sweet corn is one of the most popular vegetables in the USA, Europe and other developed countries of the world. It is a very delicious and rich source of energy, vitamin C and A. Corn is best grown in an environment that provides warm weather and long sunny days. During the day, maize is grown between 18-27 degree Celsius and during the night at 14 degree Celsius temperature is considered good for corn growth. Corn is very sensitive to frost; therefore, its cultivation is limited in temperate latitudes (Maddonni, G. A. 2012) ^[1]. During flowering, high temperature and low humidity damage the leaves weakens pollen and interfere with proper pollination, resulting in poor grain formations. 50-70 cm well distributed rain is suitable for proper growth and development.

Sweet corn can be harvested between 80 and 90 days after sowing. It is harvested 35 to 45 days prior as compared to normal corn. Its cobs has also good market potential. The weather should not be too cold or there will be slow germination, poor growth, wearing a few small ears and even death if it is damaged by frost. Green cobs are harvested after 18-20 days of pollination during *Kharif* but the duration may varies season to season. At the harvest time the moisture is generally 70% in the grain and sugar content varies from 11 to more than 20%.

Mulching is one of the most important moisture conservation practice in rain-fed agriculture among various mechanical and agronomic measures that have been reported to reduce the soil erosion and increase *in-situ* soil moisture storage. To improve the efficiency and effectiveness of water use, the most convenient agronomic management practice are cropping system, mulching and irrigation scheduling in the case of maize production. Mulching of crop residues is an encouraging management option for decreasing soil water evaporation, with other benefits at much lower costs and improved soil health. Residue mulch on the soil surface reduces evaporation, regulates soil temperature and increases soil porosity in long term practices.

2. Materials and Methods

To see the effect of different types of mulches and sowing dates on crop growth, the field experiments were conducted at plot number C4 of Norman E. Borlaug Crop Research Centre of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, U.S Nagar (Uttarakhand) during *Kharif* seasons of 2018. The experimental site is situated at latitude of 29.02°N, 79.25°E longitude and at an altitude of 238 m above the mean sea level. The average annual rainfall is 1405 mm. May is the hottest month of the year in the region and temperature generally rises up to 45.5°C. However, minimum temperature can be low as 1.5°C in the month of January. Generally, the monsoon sets in around 3rd week of June and lasts up to end of the September.



Fig 1: Plastic, Dhaincha and green weed mulch treatment

2.2 Fertilizer application

During the experiment recommended dose of nitrogen, phosphorus and potassium were applied with the rate of 150-60-40 kg per hectare respectively. Zinc was also applied at the rate of 25 kg per hectare at the time of sowing. Phosphorus and Potassium was applied as a whole at the time of sowing. Nitrogen is applied 20% as a basal dose at the time of sowing. Remaining nitrogen was applied as splitting at eight leaf stage, tasseling, and grain filling stage at the rate of 25%, 30%, and 25% respectively.

Under Plastic film mulch all the fertilizers were applied in half quantity to avoid injury by applying it in nearness to plant root zone.



Fig 2: Application of fertilizer in plastic film mulch

2.1 Treatment details

The experiment was conducted with following treatments.

Three planting date viz. 11th July, 23rd July and 21st August 2018 and four types of mulching material. Mulching treatment includes control treatment (M1), Dhaincha (*Sesbania aculeata*) (M2), green weed (M3) and black polythene mulch (M4).

Dhaincha which was used as mulch was collected from the nearby fields. In case of green weed mulch, weeds which was collected during weeding of crop at different stages was used as mulch.

Crop variety used- Maize sugar 75



3. Result and discussion

3.1 Effect on plant growth parameter

All the plant growth parameter like Plant height, Leaf Area Index and Biomass accumulation was significantly affected by different date of sowing and mulching treatment (Table 1). When compared to green weed mulch, dhaincha mulch and control treatment the plant height under plastic film mulch was 5.05, 5.95 and 0.74% higher respectively for 1st date of sowing. For second date of sowing plant height under plastic film mulch was higher by 22.18, 32.01 and 14.08% respectively and for third date of sowing the plant height under plastic film mulch was higher by 10.12, 0.27 and 7.79%. The higher plant height in polythene mulched plots might be due to excellent weed control, along with initial soil moisture and temperature. (Mahajan *et al.*, 2007) [2]. The lower plant height in dhaincha mulch treatment could be the result of competition between sweet corn and weeds for the environmental parameter such as light, water, and space which reduces photosynthesis and production (Kahangi *et al.*, 2014) [3].

Leaf area index under plastic film mulch was higher by 3.82, 11.26 and 2.01% respectively for first date of sowing when compared to green weed mulch, dhaincha mulch and control treatment. For second date of sowing leaf area index under plastic film mulch was higher by 19.46, 28.34 and 16.64% respectively and for third date of sowing leaf area index under plastic film mulch was higher by 14.60, 6.62 and 9.31% respectively. Higher leaf area index was observed for plastic film mulch treatment as a comparison to dhaincha mulch because of the lower density of weed presence, thus providing favorable conditions which also accelerated vegetative growth in particularly under polythene mulch treatment (Gul *et al.*, 2009) [4].

Dry matter accumulation under plastic film mulch was higher by 6.63, 11.45 and 5.82% respectively when compared to green weed mulch, dhaincha mulch and control treatment for first date of sowing. For second date of sowing the average dry matter accumulation under plastic film mulch was higher by 16.82, 24.20 and 5.41% respectively and for third date of sowing it was higher by 20.65, 4.68 and 6.52% respectively. The result is in accordance with Xu *et al.* (2015) ^[5] who recorded a greater accumulation of dry matter by plastic film mulching at an early stage of growth such as the pre-silking stage.

Table 1: Effect of planting date and mulching on plant height, LAI and dry matter accumulation

Plant height at harvesting (cm)				
	M1	M2	M3	M4
1 st DOS	222.33	210.67	212.67	224.00
2 nd DOS	230.00	182.00	208.30	267.70
3 rd DOS	224.67	243.00	219.00	243.67
Leaf area index at harvesting				
1 st DOS	4.88	4.41	4.79	4.97
2 nd DOS	4.91	4.38	4.65	5.63
3 rd DOS	4.51	4.12	4.38	4.83
Dry matter accumulation at harvesting (gm.)				
1 st DOS	210.41	197.79	208.56	223.39
2 nd DOS	236.50	189.50	207.97	250.04
3 rd DOS	198.57	168.55	202.47	212.43

3.2 Effect of planting date, mulching type on Developmental stages

3.2.1 Days to emergence

The number of days taken for 50 percent germination did not vary significantly either due to the date of sowing and/or due to mulches, in maize. The interaction effect of the above treatments was also found non-significant on days to 50 percent germination. The crop nearly took 5 days to attain 50 percent germination (Table 2).

3.2.2 50% Tasseling

Days taken to reach 50 percent tasseling were significantly more (57) in the second date of sowing as compared to the first and third date of sowing. Significantly, the lowest days to reach tasseling stage were recorded for the late sown maize i.e. 44.83 days. The minimum days required for 50% tasseling was 49.11 days under black polythene mulching (Table 2).

The results are in agreement with Lenka (1998) ^[6] who concluded that delay sowing in *Kharif* and summer season reduced days to tasseling. Early planting tends to place the tasseling and silking period ahead of the greatest risk of moisture stress and drought damage (Sangoi 1993) ^[7]. The early tasseling in plastic mulches could be attributed to an increase in soil moisture and temperature, which may have promoted early tasseling. These findings for the plastic mulches are in agreement with the results of Rifin (1988) ^[8] who reported that mulches induced early tasseling and silking in maize. These results are also in line with the work of Yonghe (1994) ^[9] who reported that under different cropping systems, plastic mulch significantly raised the soil temperature, kept soil water content stable and enhanced microbial activity and as a result crops grew faster.

3.2.3 50% Silking

The second sown sweet corn was found to take maximum

(58.42) days for attaining silking stage followed by the first date of sowing (51.58). Significantly, the lowest days to reach tasseling stage were recorded for the late sown maize i.e. 46.08 days. Days taken to 50 percent tasseling were significantly more in dhaincha mulch compared to other mulch treatment. Tasseling was 2 days earlier under plastic film mulch compared to dhaincha mulch treatment. Days required for 50% tasseling increased with other mulch when compared to plastic film mulch (Table 2).

The lowest days taken for silking in the late sown crop may probably be due to delayed planting of the maize crop. The results are consistent with the studies of various research workers worldwide Mosavi *et al.*, (2012) ^[10]; Ali *et al.*, (2014) ^[11] and Ahsan *et al.*, (2011) ^[12]. The early silking in plastic mulches might be attributed to the effects of mulch material in increasing soil temperature and moisture that induced early flowering and maturity (Lalitha *et al.*, 2010) ^[13].

Table 2: Effect of planting date, mulching type on Developmental stages for *Kharif* sweet corn 2018

Treatment	Germination (50%)	Tasseling (50%)	Silking (50%)
Effect of date of sowing			
D1	4.00	49.75	51.58
D2	5.00	57.00	58.42
D3	5.00	44.83	46.08
SE(m)	0.41	0.48	0.32
C.D. (at 5%)	NS	1.42	0.93
Effect of mulching			
M1	4.67	48.89	52.22
M2	4.67	51.33	52.55
M3	4.67	50.77	52.55
M4	4.67	49.11	50.77
SE(m)	0.47	0.56	0.36
C.D. (at 5%)	NS	1.64	1.08

3.3 Effect of planting date, mulching type on Yield and yield components

3.3.1 Number of grain rows cob⁻¹

Total Number of grain rows cob⁻¹ was maximum at first date of sowing followed by second and third date of sowing. The number of grains rows per cob was significantly higher in plastic film mulch (14.76) and dhaincha mulch (14.13) as compared to green weed mulch (13.53) and control (12.91) (Table 3).

3.3.2 Cob length (cm)

Highest cob length was observed with first date sown crop and lowest for late i.e. third date sown crop. Cobs are shorter under plastic film mulch. As the grain filling was not up to the top of cob, it resulted in shorter cobs (Table 3).

A decrease in cob length was noticed with delay in sowing and conformed to the findings of Ibrahim *et al.* (2013) ^[14] who reported that delayed sowing of maize from optimum sowing date would result in shorter cobs.

3.3.3 Number of grains/row

A decrease in the number of grains per row was noticed with a delay in sowing. Under different mulching treatment plastic film mulch showed low grain filling rate and number of grains in a row was also reduced. It was due the soil cover by plastic film mulch and hence over the time it reduces the soil moisture and availability of nitrogen for grain filling (Table 3).

Table 3: Effect of planting date, mulching on Cob length, No. of green cob per plant, No. of grains row per cob and No. of grains per row for *Kharif* sweet corn 2018

Treatment	Cob length (cm)	No. of cobs/plant	Grains row/cob	No. of grains/row
Effect of date of sowing				
D1	14.94	1.09	13.80	31.64
D2	13.72	1.05	13.43	29.67
D3	12.86	1.03	13.27	29.55
SE(m)	1.33	0.08	0.27	0.95
C.D. (at 5%)	NS	NS	NS	NS
Effect of mulching				
M1	13.01	1.06	12.91	30.00
M2	13.18	1.03	14.13	30.64
M3	16.40	1.09	13.53	31.32
M4	12.76	0.99	14.76	29.18
SE(m)	1.54	0.03	0.31	1.10
C.D. (at 5%)	NS	NS	0.90	NS

3.3.4 Green cob weight (10^{-2} kg)

The highest cob weight was found in the first date of sowing (30.89×10^{-2} kg) followed by second (26.05×10^{-2} kg) and the third date of sowing (23.04×10^{-2} kg) (Table 4). The significant reduction in cob weight with different sowing dates could be due to the decreased incident solar radiation in the season which finally reduced both cob length and cob weight through a reduction in biomass production (Maddonna *et al.*, 1998) [15].

3.3.5 Green cob yield (t/ha)

The maximum green cob yield was with the first date of sowing (22.72 t/ha) followed by second (17.28 t/ha) and third (16.80 t/ha) date of sowing for the *Kharif* sweet corn. The effect of different mulching material on the green cob yield of sweet corn was not significant and the green cob yield was almost equal to each other under all the mulching treatment under *Tarai* region of pantnagar (Table 4).

The maximum yield in the first date of maize sown crop has taken the advantage of optimum temperature, rainfall and sunlight during early stages of plant development and thereby avoided adverse situations during its life cycle whereas, the minimum yield for the last date of sowing may be attributed to high-stress conditions of increased maximum and minimum temperature coupled with sunshine duration. The findings are in the tune with Girijesh *et al.* (2011) [16]; Singh and Hadda, (2014) [17].

3.3.6 Grain yield (10^2 kg/ha)

The maximum grain yield (76.20 kg/ha) obtained with the first date of sowing and was significantly higher when compared to second (69.60 kg/ha) and third date of sowing (64 kg/ha). The seed yield is the function of the combined effect of all the yield components under the influence of a particular set of environmental conditions. The delay in planting gradually decreased the yield because of a decrease in temperature at the end of the season.

Higher grain yield was recorded with dhaincha mulch (75.80 kg/ha) when compared with green weed mulch (68.30 kg/ha), control treatment (68.30 kg/ha) and plastic film mulch (67.50 kg/ha). Grain yield under dhaincha mulch treatment was higher by 9.88%, 11% and 9.88% for green weed mulch, control treatment, and plastic film mulch respectively (Table 4). Reduced grain yield under plastic film mulch was the combined result of short cob length, lowest number of gains per row and low gain filling rate.

Schopher *et al.* (1982) [18] reported that increasing light interception through early planting date has increased maize yields. In a study carried out by Johnson and Mulvaney (1980) [19], higher grain moisture and 5% yield loss was generally recorded at harvest in the case of late planted maize hybrids.

Table 4: Effect of planting date, mulching type on Green cob weight (10^{-2} kg), Test weight (g), Green cob yield (t/ha) and Grain yield (10^2 kg/ha) for *Kharif* sweet corn 2018

Treatment	Green cob weight (10^{-2} kg)	Test weight (g)	Green cob yield (t/ha)	Grain yield (10^2 kg/ha)
Effect of date of sowing				
D1	30.89	22.19	22.72	76.20
D2	26.05	20.95	17.28	69.60
D3	23.04	20.83	16.80	64.00
SE(m)	1.12	0.22	0.26	1.10
C.D. (at 5%)	3.79	0.66	0.78	2.20
Effect of mulching				
M1	27.22	21.66	19.04	68.30
M2	26.06	21.46	19.24	75.80
M3	24.58	21.22	18.17	68.30
M4	28.96	20.94	19.28	67.50
SE(m)	1.40	0.26	0.31	0.80
C.D. (at 5%)	NS	NS	NS	2.50

4. Reasons for low grain yield under plastic film mulch

Plants under polythene mulch initially grow faster due to the availability of the initial soil moisture and nutrient but when the plant goes through vegetative and grain filling stages the availability of soil moisture and nitrogen fertilizer is in

limited amount and hence it results in lower grain filling in sweet corn crop under polythene mulch treatment.

Under polythene film mulch the grain yield was not significantly higher when compared with the other treatment of the study. There were mainly two reasons for it:-

- The area for the application of fertilizers under plastic film mulch was lower and thus half of the amount of fertilizer were applied at different growth stages. This was done to prevent injury due of higher amount of urea to be applied near the plant root zone. This results in low availability of nitrogen to the plant at the time of grain filling stage and thus ultimately affects the final grain yield.
- Another reason for the lower grain yield was the lower availability of water in the plastic film mulch treatment at the later stages of plant growth. At the time of irrigation, most of the water remained on the polythene mulch and thus water didn't penetrate the soil. It resulted in the lower soil moisture under the polythene mulch.

Under the dhanincha mulch treatment the crop growth parameter like plant height, leaf area index, dry matter accumulation was lower as compare to the other treatment during the experimental period. Application of dhanincha as a mulch is not enough to suppress the weed population so weed accumulation was very high during the period of crop growth. High accumulation of weed resulted to competition with maize crop and hence corn plants are shorter in height and low in accumulation of biomass.

As dhaincha act as a green manuring in field so the organic matter content of soil can be increased by green manuring with dhaincha (*Sesbania rostrate*), which contains about 1.25% N (Hossain *et al.*, 1990)^[20] and supplies 200 kg N/ha when incorporated 50 days after sowing (Rinaudo *et al.*, 1983)^[21]. Furthermore, green manuring together with nitrogen fertilizer helps release nutrients more slowly during the period of crop growth (Singh *et al.*, 1990)^[22].

The slow release of nitrogen in dhaincha mulch and supply of nitrogen in later growth stage enhances the grain filling rate and it resulted in more grains in sweet corn. It finally result in more grain yield.

5. Conclusion

All the crop growth parameter like plant height, leaf area index, biomass accumulation was higher under plastic film mulch as compare to other mulching material. As optimum plating date provides better growing condition for plat growth. Hence 11th July sown crop results in higher green cob yield and grain yield as compare to 23rd July and 21st August sown crop. As all plant growth parameters are higher for plastic film mulch but it is not same for grain yield. Due to above said reason grain yield was reduced for plastic film mulch and higher for dhaincha mulch treatment. Organic mulches are efficient for moisture conservation and also to increase soil fertility in long turn.

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