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Effect of rainwater conservation practices and mulching on yields and harvest index production of maize (*Zea mays* L.) under changing climate

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Abstract
Present experiment was laid out at soil conservation and water management farm, C.S. Azad University of Agriculture and Technology Kanpur, during rainy season of 2018-19 and 2019-20. The effect of four rain water conservation practices i.e., farmer practices, ridge and furrow, micro julkund between rows, flat sowing with earthing and three mulching vez., no mulching, organic mulching @ 4 t/ha and GM biomass mulching (Dhaincha) was studied. The significantly highest cob diameter was measured under ridge and furrow practice (12.42 cm). The minimum cob diameter was recorded under farmer practice (11.45 cm) in pooled results of two years. Green maturing biomass mulching displayed highest cob diameter (12.06 cm). The minimum diameter of cob was measured under no mulching (11.75cm) in pooled results of two years. The significant highest length of cob was measured under ridge and furrow practice (20.39 cm). The minimum cob length was recorded under farm practice (18.45 cm) in pooled results of two year Ridge and furrow treatment of rain water conservation practices gave highest grain yield (34.98 q/ha), which significantly superior than farm practice. The farmer practice gave minimum grain yield (29.82 q/ha). The grain yield (36.88 q/ha) of maize significantly higher under green maturing biomass mulching as compared to other mulching practices. The minimum grain yield (28.78 q/ha) was recorded in no mulching practice in pooled results of two years.

Keywords: Rain water conservation practices - Farmer practices R_1 Ridge and furrow R_2 Microjalkund between rows R_3 Flat sowing with earthing R_4, Mulching - No mulching (control) M_1 Organic mulch @ 4 t ha^{-1} M_2 and GM biomass mulching (Dhoincha) M_3

Introduction
In Uttar Pradesh rainy season maize, cultivating in 6.74 lakh ha which produced grain by 13.92 lakh mt. with productivity of 20.67 q ha^{-1}. The productivity of Uttar Pradesh is low in comparison of national productivity (Anonymous, 2019) [3]. The effects on rainwater management practices different type use of mulching, varietal improvement etc. was made to increase the grain productivity of rainy season maize all over the country. Out of which some have been described here.

In India the bulk of the maize crop is grown during *kharif* season, more or less as rainfall crop. However, there are few agro- climate zones such as a Tarai in UP, part of peninsular India, Bihar and Gujarat, where maize is grown in *kharif* as well as in *ravi* and/or spring as and irrigated crop. Irrigation and water management, therefore, assume the greater importance when maize is taken as irrigated crop. *Kharif* sown crop hardly need the supplemental irrigations under adequate and well distributed rainfall. Although there are certain critical stages in hybrid maize at which lack of soil moisture reduce the yield considerably. At the critical stage, even in *kharif* sown crop, adequate soil moisture is needed to fully exploit the yielding potentiality of maize varieties. Supplemental water management practices are, therefore, required only when there is soil moisture stress at critical stages are under inadequate and scanty rainfall.

For irrigated crop of hybrid and composite, irrigation at 70 to 80% moisture availability has given result. A crop raised during summer and in light soil requires more frequent irrigations with an interval of one week. However is soils of medium texture, irrigation once in 10 to 15 days depending upon the quantum of rainfall received during the season has been found satisfactory. Rainfall crop should be irrigated only under prolonged drought condition to avoid moisture stress at critical stages. In hybrid maize, late knee high stage, tasseling and silking stages are more critical for irrigation. Under limited irrigated water supply, maintain the soil moisture through productive irrigations at tasseling and silking stages.

Materials and Methods

A field experiment was conducted on response of row spacing, bio-fertilizer and nitrogen levels on yields and economics of chickpea at Soil Conservation and Water Management Farm, Department of Soil conservation and water management of Chandra Shekhar Azad University of Agriculture & Technology, which is situated in the alluvial tract of Indo - Gangetic plains in central part of Uttar Pradesh between 25° 26' to 26° 58' North latitude and 79° 31' to 80°34' East longitude at an elevation of 125.9 m above mean sea level. The experiment was layout in a three replicated split plot design with 4 treatments of rain water conservation practices assigned to the main-plots and 3 mulching practices randomly placed in sub-plots.

The treatments and other details are given below.

S.N.	Treatment	Symbols
A.	Rain water conservation practices-**4 (Main plots)**	
(i)	Farmer practices	R_1
(ii)	Ridge and furrow	R_2
(iii)	Microjalkund between rows	R_3
(iv)	Flat sowing with earthing	R_4
B.	Mulching -3 (Sub-plots)	
(i)	No mulching (control)	M_1
(ii)	Organic mulch @ 4 t ha^{-1}	M_2
(iii)	GM biomass mulching (Dhoincha)	M_3

Allocation of treatments

The treatments were randomly allocated in the assigned plots in each replication.

Details of layout

Numbers of replication	3
Design of experiment	Split plot design
Number of treatment	12
Total number of plots	12 x 3 = 36
Main plot size	5.0m x 4.5 m = 22.5 m^2
Net plot size	4.20 m x 3.60 m= 15.12m^2
Plant spacing	45 x 20 Cm
Test crop	Maize @ HQPM -2
Field border	2 m
Replication border	1 m
Plot mend	0.5 m

Cultural operations

Firstly, they experimental plots were ploughed by plourhing with mould board plough. Thereafter all plots were ploughed three times with cultivator followed by planking. After find layout on the field, half dose of the nitrogen and full dose of phosphorus and potash were applied through 'nai' behind deshi plough in furrows 4-5 cm below with seed at the time of sowing to all plots, remaining half dose of nitrogen was top-dressed at 30 days after sowing. The 20 kg seed of maize HQPM – 2 was sown in furrows by deshi plough with the help of manual labours keeping row to row distance of 45 cm. Planking was done just after sowing to cover the seeds properly. Replication borders and plots mends were made just after a day of sowing. The visible gaps in row were filled after about two week by dibbling the seed. Likewise, thinning was made to maintain the plant to plant distance by 20 cm. After 30 DAS the crop was weeded out and simultaneously surface soil was loosened by Khurpi.

As per treatments, rain water management practices, mulching and earthling were made to utilize the conserved moisture. The experimental crop was carefully watched from very beginning up to harvest of crop to prevent crop damage by birds especially parrots, animal etc. After harvesting of the sample plants separately the net plot wise maize crop was harvested at maturity stage in the help of sickle for further study. The harvested crop was left in field for sun drying which was there collected and weighed plot- wise. The kernels were separated from the dried cobs. The threshing and kernelling were done plot – wise and kernel yield of each plot was recorded and finally computed in terms of quintal per hectare.

Results and Discussion

Grain yield (q/ha)

The data on grain yields (q/ha) were analysed statistically and the results of both years and pooled of two years have been presented in Table-1.

It is clear from the results given in table-1that ridge and furrow practice gave highest grain yield, which was higher than the all other practices of rain water conservation practices in both the years of study and pooled results of two years. The two years results and pooled results of two years under ridge and furrow practice established its significantly superiority over farm practice but statistically at with microjalkund between rows and flat sowing with earthing. Therefore, the order of performance of rain water conservation practices was ridge and furrow (34.98 q/ha) > microjalkund between rows (33.90 q/ha) > flat sowing with earthing (33.66 q/ha) > farm practice (29.82 q/ha). Under ridge and furrow practice treatment 17.30 percent more yield obtained over farm practice. Resulted that Hanamant *et al*. (2017) [6]

Under mulch practices, green manuring biomass mulching produced significantly highest grain yield as compared to other mulching practices in both the experimental seasons and pooled results of two years. Therefore, the order of performance of mulch practices was green biomass mulching (36.88 q/ha)> organic mulching @ 4 t/ha (33.60 q/ha)> no mulching (28.78 q/ha). The 28.15 percent more yield obtained in green manuring biomass mulching over no mulching. The interaction effect between rain water conservation practices and mulching was found absent.

Table 1: Effect of Rain water conservation practices and Mulching on grain yield q ha^{-1} and biological yield q ha^{-1} and harvest index of maize during both year session 2018-19 &2019-20 with pooled

Treatment	Grain yield (q ha^{-1})			Biological yield (q ha^{-1}) Harvest Index (%)					
	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
Farmer practice (R_1)	29.39	30.24	29.82	78.27	79.37	78.82	37.54	38.10	37.82
Ridge& furrow (R_2)	34.86	35.10	34.98	90.96	91.67	91.31	38.32	38.28	38.30
Micro jalkund between rows (R_3)	33.66	34.15	33.90	88.02	88.79	88.10	38.24	38.46	38.35
Flat sowing with earthing (R_4)	33.58	33.73	33.66	87.55	87.94	87.74	38.35	38.35	38.35
S.E. (m±)	0.78	0.89	0.59	1.15	1.13	0.80	0.19	0.17	0.13
C.D. 5%	2.70	3.10	1.83	3.98	3.90	2.49	N.S.	N.S.	N.S.
No mulching (M_1)	28.60	28.96	28.78	75.02	75.80	75.41	38.12	38.20	38.16
Organic mulching @ 4 t/ha (M_2)	33.52	33.69	33.60	87.38	87.78	87.58	38.36	38.38	38.37
G.M. biomass mulching (M_3)	36.64	37.13	36.88	96.35	97.09	96.72	38.02	38.24	38.13
S.E. (m±)	0.72	0.86	0.56	1.03	1.01	0.72	0.15	0.16	0.11
C.D. 5%	2.18	2.60	1.63	3.10	3.05	2.09	N.S.	N.S.	N.S.

Biological yield (q ha^{-1})

The biological yield (q/ha) measured at harvest were analysed also concluded that Hanamant *et al*. (2017) [6] results have been given in Table-1 for both the years and also for pooled results of two years. The results displayed that ridge and furrow practice registered significantly maximum biological yield during both the experimental seasons over the farmer practice, but statistically at par with microjalkund between rows and flat sowing with earthing. The pooled results of two years also indicated the supremacy of ridge and furrow practice, which was more effective in increasing biological yield in comparison to all other tested rain water conservation practices. Farm practice produced lowest biological yield during two years and in pooled results. Under mulching practices, green manuring biomass mulching displayed the significantly higher biological yield over other two practices of mulching in two years investigation as well as in pooled results of two years. No mulching practice was produced lowest biological yield in two experimental seasons and in pooled results of two years this is also reported Wang *et al* (2011) [8]. The interaction effect between rain water conservation practices and mulching methods was noted insignificant.

Harvest index (%)

It is obvious that not much variation was found between rain water conservation practices during two year investigation and pooled years. However, ridge and furrow microjalkund between rows and flat sowing with earthing practices of rain water conservation practice displayed the superiority over farm practices of moisture management in both the years and in pooled results of two years. Not much variation was found in mulching methods during two years investigation and pooled results of two years. Though this practice was significantly superior over no mulching practice in second year result and pooled results of two years. The interaction effect between rain water conservation practices and mulching methods was also found absent. This result also confined Liu *et al.* (2017) [5] Wang *et al* (2011) [8]. and Wang *et al* (2011) [8].

Summery and Conclusion

Ridge and furrow treatment of rain water conservation practices gave highest grain yield (34.98 q/ha), which significantly superior than farm practice. The farm practice gave minimum grain yield (29.82 q/ha). The grain yield (36.88 q/ha) of maize significantly higher under green manuring biomass mulching as compared to other mulching practices. The minimum grain yield (28.78 q/ha) was recorded in no mulching practice in pooled results of two years.The stover yield of maize was recorded significantly higher in ridge and furrow practice (56.34 q/ha) as compared to farm practice and flat sowing with earthing treatments. The minimum yield was recorded under farm practice (48.99 q/ha) in pooled results of two years. The stover yield was found significantly maximum (59.83 q/ha) in green manuring biomass mulching and the lowest stover yield was recorded in no mulching (46.63 q/ha) Liu *et al.* (2017) in pooled results of two years. Ridge and furrow practice of rain water conservation practices produced significantly maximum biological yield (91.21 q/ha) over all the tested moisture conservation practices. The lowest biological yield recorded under farm practice (80.61 q/ha) in pooled results of two years. Green manuring biomass mulching gave significantly higher biological yield (96.94 q/ha) over other tested mulching practices, while lowest biological yield was weighed under no mulching practice (76.27 q/ha) in pooled results of two years. Between rain water conservation insignificant variation was recorded in pooled results of two years. The different type mulch practices did not display the significant response in pooled results of two.

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