Indian J. Agric. Res., 52(5) 2018: 481-488
Print ISSN:0367-8245 / Online ISSN:0976-058X

AGRICULTURAL RESEARCH COMMUNICATION CENTRE
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Study on germination and soil physical factors for establishment of maize (*Zea mays* L.) by conservation techniques in North Bengal

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Received: 05-05-2017 Accepted: 22-08-2018 DOI: 10.18805/IJARe.A-4783

ABSTRACT

Light textured acid soil with conventional culture of growing crops faces poor germination due low moisture retention with infrequently quandaries like restricted activity of salutary soil micro-organisms and ultimately poor yield. To combat these soil health problems and to ameliorate the overall productivity of northern Bengal region an experiment was done at Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, with split-split plot design having two main-plot and two subplot mulching treatments and four sub-sub plot nutrient management treatments. The observations with conservation techniques on three year studies overcome the quandaries and showed positive cognation between soil moisture and germination. Difficulty with establishment of maize and reduced yield was additionally solved with soil health benefits.

Key words: Conservation techniques, Establishment, Germination, Maize, Soil moisture, Temperature.

INTRODUCTION

In traditional agriculture, the aim of tillage can be summarized as to engender a felicitous seedbed, kill weeds, for reducing competition and conserving water and abstract restrictions to infiltration, drainage and ultimately promoting crop germination and establishment. Generally a good germination can be achieved by retaining optimum soil moisture and temperature. But traditional or conventional tillage disrupts the soil structure and biotic activity of soil. So, the term conservation tillage refers to water conservation and reduction of soil erosion. In additament, minimum tillage reduces time, fuel as well as labour requisites (Sullivan, 2003), whereas mulching mitigates soil temperature and increases water infiltration (Gajri *et al.*, 1994). In the case light textured acid soil of North Bengal with traditional culture, poor germination with low moisture retention is the major drawback, with circumscribed availability of multiple plant nutrients and restricted activity of soil micro-organisms. To combat these soil health cognate difficulties, the possible weapons for soil conservation techniques are conservation tillage, mulching and incorporation of ample amount of good quality organic matter. So the recent study well documented that there is a positive correlation between soil moisture and germination and is best exploited under organic management strategies and the residues left on the soil eliminates soil loss by averting water and wind erosion and amends soil physical and biological properties of soil.

MATERIALS AND METHODS

The experiment was carried out at Instructional Farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal during 2010, 2011 and 2012. The farm is situated at 26° 19/ *86*// N latitude and 89° 23/ 53// E longitude and at an altitude of 43 meters above mean sea level. The soil is sandy loam, acidic with a pH of 5.85, 0.52% organic carbon. The experiment was laid out in split-split plot design with two main-plot treatments (C_1=conventional tillage and C_0=zero tillage), two subplot treatments (M_1=wheat straw mulching @ 4 Mg ha^{-1} and M_0=unmulched) and four sub-sub plot treatments (V_1=75% RD + Vermicompost @ 5t ha^{-1}; V_2=75% RD + Vermicompost @ 7.5t ha^{-1}; V_3=75% RD + Vermicompost @ 10t ha^{-1}, and V_4=100% RD where RD= Recommended dose of fertilizers @ of 120 kg ha^{-1} nitrogen, 60 kg ha^{-1} phosphorus and 60 kg ha^{-1} potassium) and replicated thrice with a plot size of 3m x 4 m. The undisturbed soil cores were amassed afore and at the harvest of maize crop from all the treatments in 0–15 cm soil layers. The same soil cores were utilized for determining the bulk density (Mgm^{-3}) and maximum water holding capacity of soils after saturating these through capillarity (Baruah and Barthakur, 1997). Soil microbial biomass carbon was estimated by the chloroform fumigation (12 h) – extraction method (Vance *et al.* 1987). Soil temperature upto 40 cm depth was quantified by mercury glass thermometers at every 15 day interval temperature 2 different times a day. Moist samples were weighed and oven dried at 105°C to give the soil moisture percentage (Baruah and Barthakur, 1997). Soil organic matter was determined as laboratory manual of Ryan *et al.* (2001). Two blank readings were obtained by following above procedure except adding soil. Germination percentage was calculated by counting seeds

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Table 1: The mean temperature and mean rainfall for the experimental period.

Months	Jan	Feb	Mar+	Apr+	May+	June+	July+	Aug+	Sept+	Oct+	Nov	Dec
Avg. temperature (°C)	21.47	27.7	31.1	30.9	30.9	31.5	31.5	32.7	31.9	32.5	26.8	22.7
Avg. Rainfall (mm)	0.7	4.6	1.95	48.85	231.3	532.6	493.05	436.95	336.6	71.2	6.55	16.55

at sowing, and then germinated seeds were counted at 5 and 10 days after sowing. Then it was converted in to percentage. The mean temperature and mean rainfall for the experimental period denoting with '+' are given (Table 1).

RESULTS AND DISCUSSIONS

Germination affected by soil moisture and temperature: Germination percentage was significantly affected by mulching and fertilizer treatments (Table-2) but not by tillage treatments (except first year at 5 DAS and final year at 10 DAS) Singh and Suman (2007) additionally found that minimum perturbance of soil incremented germination of seeds with more congenial micro environment.

Fittings of polynomial curve (PCF) (Fig 1,2,3,4,5 and 6 a, b, c and d) showed negative correlation between soil temperature and germination percentage under tillage variation, whereas, positive correlation between the same was observed under mulching treatment at 5 DAS. Correlation values between temperature and germination (Fig 4 e, f, g and h) was even higher at later stage of germination period (10 DAS). However, linear curve fittings (LCF) (Fig 1,2,3,4,5 and 6 e, f, g and h) showed positive correlation between soil moisture and germination percentage under tillage variation and mulching treatment at both the stages of germination period (5 and 10 DAS). Zero tillage and straw mulching was able to maintain a moderate temperature regime to have the higher percentage of germination from the very initial stages (5 and 10 DAS) and had the higher correlation values between temperature and germination percentage.

The highest germination percentage was described in case of mulching @ 4 Mg ha^{-1} treatments than unmulched at 5 and 10 DAS during both the years. Mulching @ 4 Mg ha^{-1} treatments recorded a significantly lower soil temperature and higher soil moisture in summer season during the years of experimentation. Kindred findings was observed by Verma and Singh (2008), Singh and Suman (2007). Under rainfed condition, in zero tillage and mulching, higher amount of crop residue/straw was maintained which in turn conserved higher calibers of moisture in a propitious way at the season of low soil moisture content.

Conservation techniques and soil physical factors: Conventional tillage system performed lower bulk density in the third season but stagnant density was recorded with Zero tillage (ZT) except 15-30 cm depth (Table 3) where seasonal distinctions between conventional and zero tillage was visually perceived respectively. Conventional tillage loosened the soil and decremented the bulk density and a distinct hard and compact layer had developed below the ridges (25cm) in zero tillage. An increase in bulk density was documented in mulching at 15-30 cm due to the fact that more preponderant amount of successive vermicompost application along with slow decomposition of straw mulch in mulched plots incremented the pore space indirectly elevating the soil volume with the reduction in bulk density (Saha *et al.*, 2010) (Table 3). Irrespective of conservation techniques, lowered bulk density with an incrementation in soil OC content, high categorical surface area, elastic properties, and high moisture absorbency of soil OM.

No tillage system non significantly showed increase in water holding capacity (0-30 cm depth) with remote vicissitudes in conventional tillage during the experimental seasons (Table 3). Higher moisture retention capacity in zero tillage system (ZT) compared to conventional tillage system (Table 3) proved that additament of substantial amount of organic matter (vermicompost) brought better soil aggregation, stability and bond among the particles, which indirectly affects in higher moisture holding and in no-tillage, amelioration in those above mentioned properties, retains from the commencement due to no soil perturbance and residue maintenance (Saha *et al.*, 2010). Straw mulching @ 4 Mg ha^{1} establish maximum moisture retention because of incremented organic matter content of soil established by the further decomposition of straw materials in integration to successive application of vermicompost, which is the sole organic matter source in unmulched soil, concluded by Das and Gautam (2003); Patil and Sheelavantar, (2006).

Conservation techniques and soil biological carbon factors (μg g^{-1}): Organic matter input from mulches and weeds leads to the average concentration of microbial biomass carbon higher in zero tillage from conventional tillage at 30 cm depth, throughout the years of study respectively (Table 3 and Fig 7). Mulching @ 4 Mg ha^{-1} significantly incremented microbial biomass carbon than no mulch because of ameliorated soil physical properties i.e. soil moisture, temperature and overall soil organic matter content buildup (Table 3). Under nutrient management practices vermicompost @ 10t ha^{-1} with 75% of recommended doses significantly documented higher MBC. Rapid replication by microbial biomass to transmuted soil management, frequently act as a soil quality bespeaker (Powlson *et al.*, 1987). But, the highest decline in the MB-C in the frequent till treatment (Table 3) might be credited to the abstraction of weeds from the fields; and the soil temperature induced mineralization of the labile carbon (Gosai *et al.*, 2009). Organic matter was found to be a

Table 2: Soil conservation technique on germination percentage of maize.

	Soil temperature (°C)									Soil moisture (%)									Germination percentage (%)					
	At sowing			5 DAS			10 DAS			At sowing			5 DAS			10 DAS			5 DAS			10 DAS		
Treatments	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Tillage system (C)																								
C_1	29.4	29.1	29.2	30.2	28.6	28.7	30.2	29.2	29.3	17.01	17.09	18.84	15.78	17.45	18.51	15.04	15.56	16.34	49.88	51.56	51.57	72.63	79.91	78.90
C_0	29.0	27.2	27.6	28.2	27.6	27.4	28.7	27.3	27.2	18.77	18.86	17.11	17.42	18.52	17.47	16.48	16.36	15.58	52.63	51.9	52.35	76.45	82.00	83.73
S.E. ±	1.28	0.37	0.35	1.26	0.32	0.35	1.36	1.22	1.22	0.08	0.08	0.08	0.08	0.09	0.09	0.18	0.09	0.09	0.31	0.29	0.28	0.97	0.53	0.64
C.D (p=0.05)	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	0.49	0.49	0.50	0.51	0.56	0.56	1.09	0.54	0.55	1.89	N.S.	N.S	N.S.	N.S.	3.87
Mulch levels (M)																								
M_1	27.2	27.4	27.3	27.2	26.3	26.2	27.2	26.3	26.2	18.75	18.85	18.85	17.4	18.85	18.84	16.49	16.74	16.73	58.72	58.37	58.61	84.32	89.19	89.60
M_0	31.2	29.5	29.5	31.2	29.9	29.9	31.7	30.2	30.2	17.02	17.11	17.11	15.8	17.13	17.13	15.04	15.19	15.19	43.79	45.09	45.31	64.77	72.72	73.03
S.E. ±	0.38	0.93	0.93	0.38	0.88	0.89	0.52	0.37	0.39	0.37	0.38	0.38	0.34	0.36	0.36	0.36	0.33	0.33	0.44	0.46	0.46	0.89	1.64	1.63
C.D (p=0.05)	1.51	N.S.	N.S.	1.5	3.49	3.49	2.04	1.49	1.55	1.47	1.48	1.48	1.33	1.41	1.41	1.40	1.28	1.38	1.71	1.79	1.80	3.48	6.42	6.39
Nutrient management (V)																								
V_1	29.0	28.3	28.2	29.0	27.9	27.9	29.5	28.2	27.9	17.71	17.79	17.79	16.44	17.82	17.82	15.19	15.80	15.79	48.64	49.12	49.31	72.22	78.47	78.82
V_2	29.2	28.4	28.3	29.2	28.1	28	29.0	28.3	28.2	18.01	18.1	18.09	16.72	18.11	18.11	16.25	16.08	16.08	52.67	53.46	53.71	76.89	83.24	83.60
V_3	29.7	28.9	28.8	29.8	28.7	28.6	29.0	28.5	28.5	18.61	18.69	18.70	17.26	18.69	18.69	16.33	16.61	16.60	57.77	58.02	58.27	82.37	87.26	87.65
V_4	29.0	28.2	28.2	28.8	27.7	27.7	29.2	28.2	28.2	17.23	17.32	17.31	16.0	17.33	17.32	15.28	15.38	15.38	45.93	46.33	46.55	66.68	74.86	75.20
S.E. ±	1.11	1.06	1.06	1.1	1.03	1.03	1.07	1.06	1.06	0.71	0.71	0.71	0.66	0.71	0.71	0.69	0.63	0.63	1.28	1.27	1.28	1.77	1.34	1.35
C.D (p=0.05)	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	3.12	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	3.72	3.72	3.74	5.17	3.92	3.94

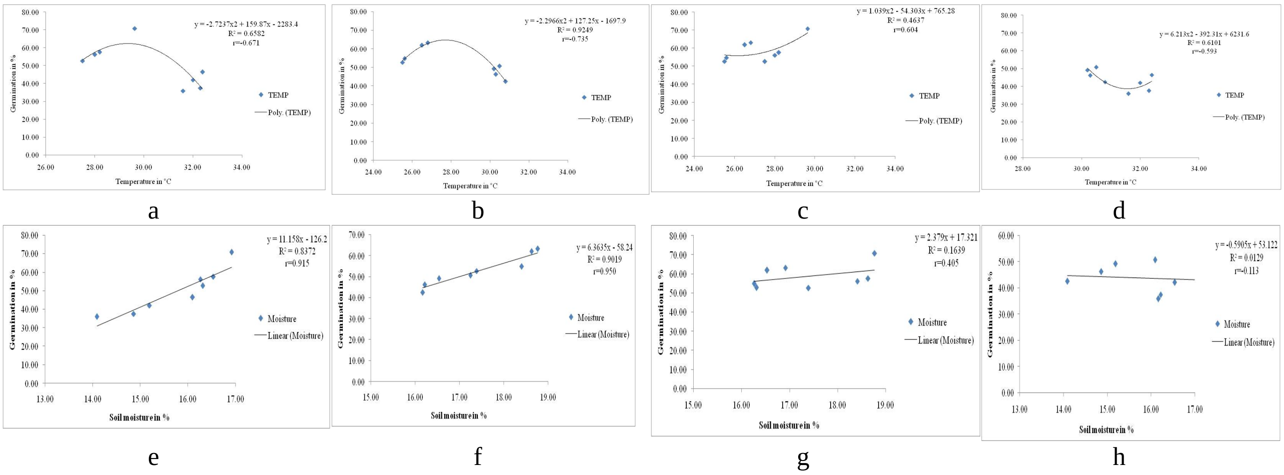

Fig 1: Polynomial curve fitting (PCF) of soil temperature w.r.t germination at 5 DAS on (a) CT, (b) ZT, (c) mulching and (d) without mulching (first row) , LCF of soil moisture w.r.t germination (e) CT, (f) ZT, (g) mulching and (h) without mulching (second row).

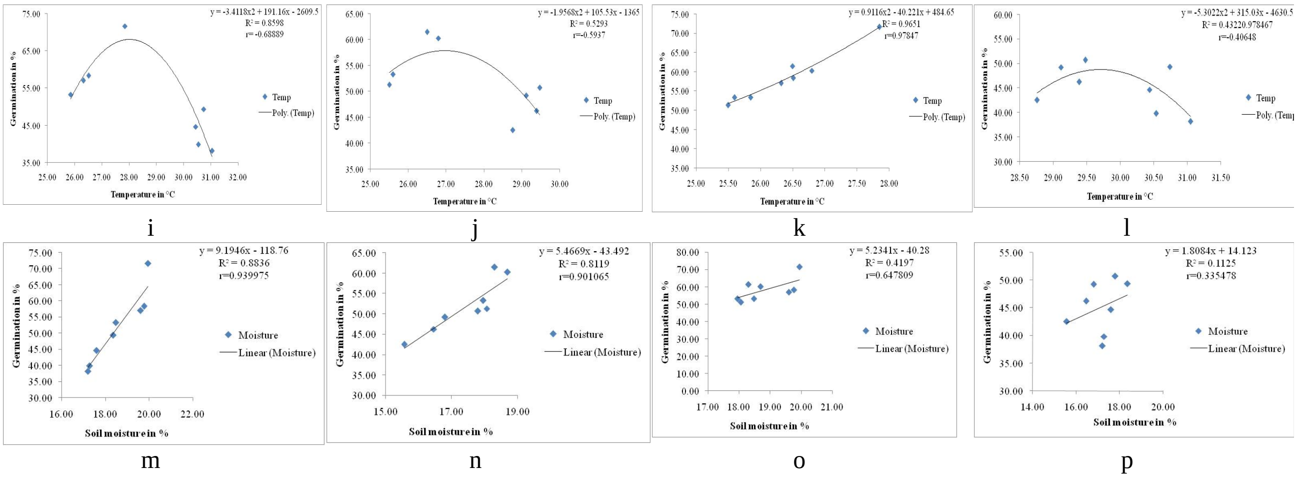

Fig 2: PCF of soil temperature w.r.t germination at 5DAS on (i) CT, (j) ZT, (k) mulching and (l) without mulching (first row), LCF of soil moisture w.r.t germination (m) CT, (n) ZT, (o) mulching and (p) without mulching (second row).

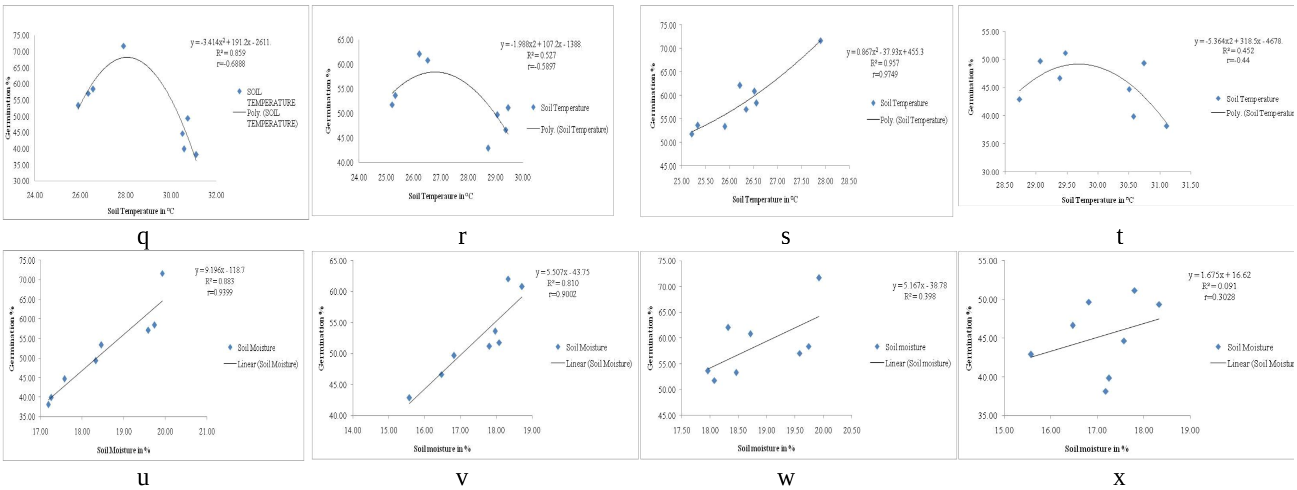

Fig 3: PCF of soil temperature w.r.t germination at 5 DAS on (q) CT, (r) ZT, (s) mulching and (t) without mulching (first row), LCF of soil moisture w.r.t (u) CT, (v) ZT, (w) mulching and (x) without mulching (second row).

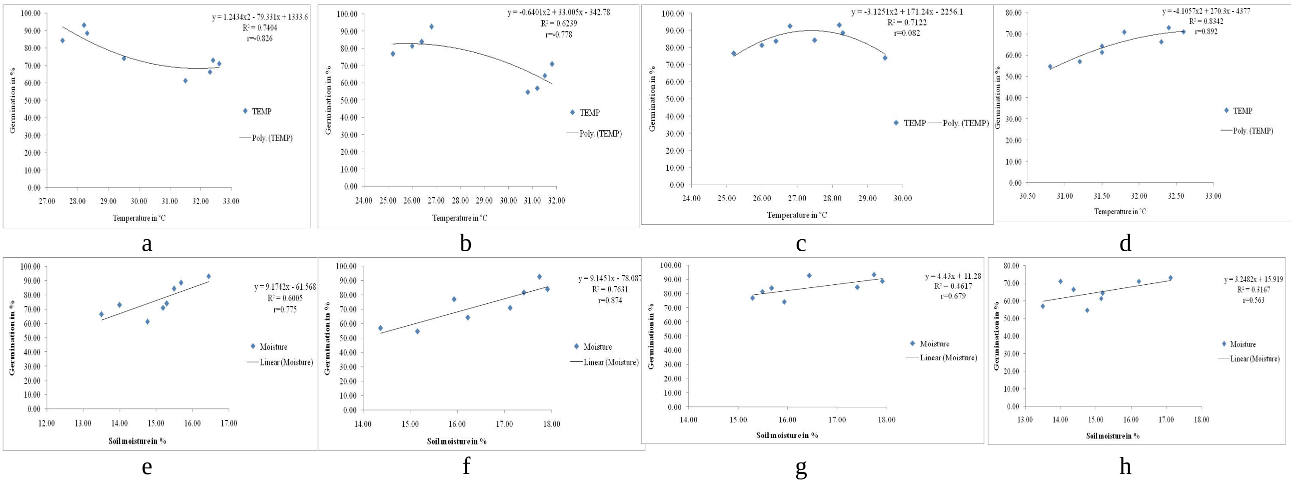

Fig 4: Polynomial curve fitting (PCF) of soil temperature w.r.t germination at 10 DAS on (a) CT, (b) ZT, (c) mulching and (d) without mulching (first row) , LCF of soil moisture w.r.t germination (e) CT, (f) ZT, (g) mulching and (h) without mulching (second row).

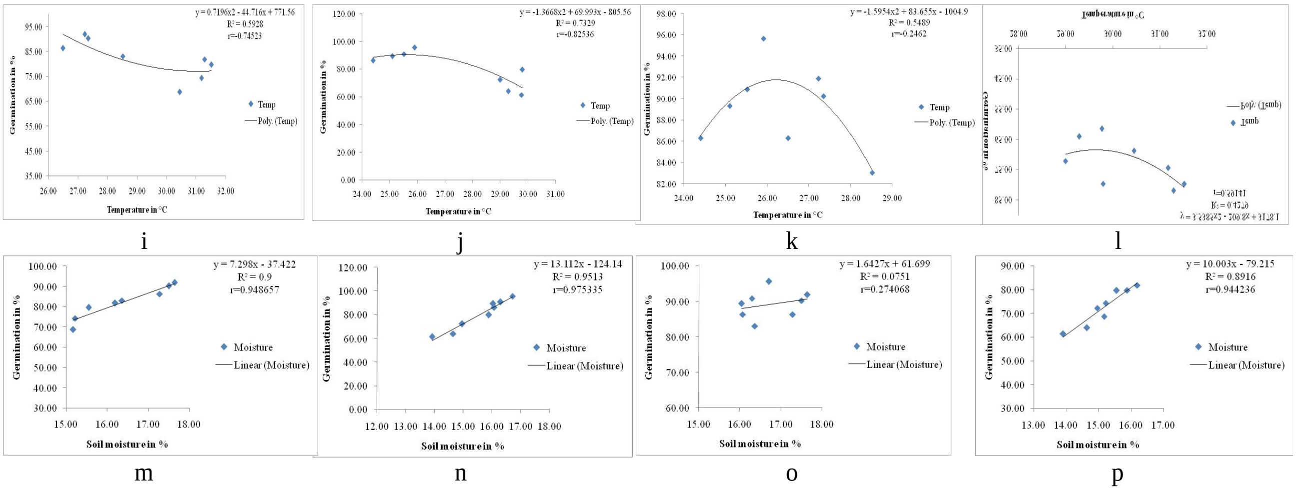

Fig 5: PCF of soil temperature w.r.t germination at 10 DAS on (i) CT, (j) ZT, (k) mulching and (l) without mulching (first row), LCF of soil moisture w.r.t germination (m) CT, (n) ZT, (o) mulching and (p) without mulching (second row).

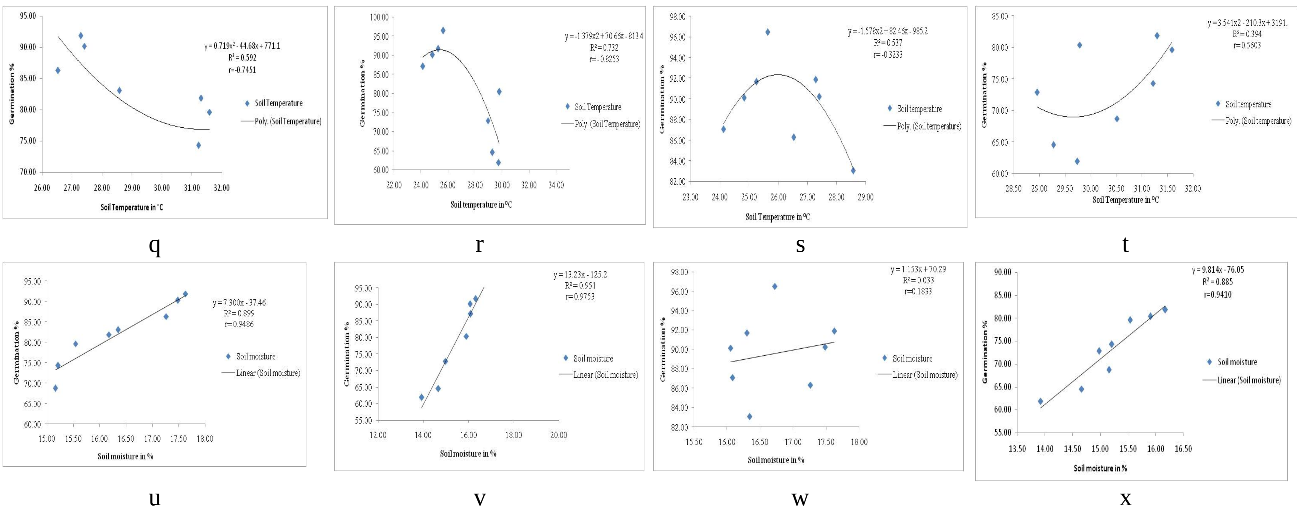

Fig 6: PCF of soil temperature w.r.t germination at 10 DAS on (q) CT, (r) ZT, (s) mulching and (t) without mulching (first row), LCF of soil moisture w.r.t (u) CT, (v) ZT, (w) mulching and (x) without mulching (second row).

Table 3: Soil conservation techniques on soil physical and biological carbon after harvesting maize

	Bulk density (g cc^{-1})						Water holding capacity (w/w %)			Microbial biomass carbon(µg g^{-1})			Organic carbon (%)		
	0-15 cm			15-30 cm			0-30 cm depth			0-30 cm depth					
Treatments	**2010**	**2011**	**2012**	**2010**	**2011**	**2012**	**2010**	**2011**	**2012**	**2010**	**2011**	**2012**	**2010**	**2011**	**2012**
Tillage system (C)															
C_1	1.47	1.47	1.45	1.44	1.42	1.42	41.80	41.75	41.53	319.65	294.08	293.08	0.71	0.71	0.70
C_0	1.47	1.47	1.47	1.44	1.44	1.46	43.28	43.60	44.13	400.29	404.30	408.35	0.73	0.75	0.74
S.E. ±	0.005	0.005	0.005	0.005	0.005	0.005	0.55	0.58	0.53	1.17	1.43	1.48	0.03	0.04	0.04
C.D (p=0.05)	N.S.	N.S.	N.S.	N.S.	N.S.	0.033	N.S.	N.S.	N.S	7.14	8.72	9.02	NS	NS	NS
Mulch levels (M)															
M_1	1.47	1.47	1.46	1.43	1.43	1.44	43.95	43.53	43.95	380.7	368.7	370.30	0.74	0.76	0.76
M_0	1.47	1.47	1.46	1.45	1.44	1.45	41.14	41.8	41.71	339.2	329.7	331.2	0.70	0.70	0.69
S.E. ±	0.005	0.005	0.005	0.003	0.003	0.003	0.85	0.74	0.78	1.64	1.65	1.67	0.03	0.03	0.03
C.D (p=0.05)	N.S.	N.S.	N.S.	0.011	0.011	0.011	N.S.	N.S.	N.S	6.43	6.48	6.54	NS	NS	NS
Nutrient management (V)															
V_1	1.47	1.47	1.46	1.44	1.44	1.44	43.68	43.63	43.77	352.0	341.6	343.10	0.72	0.73	0.72
V_2	1.46	1.46	1.46	1.44	1.43	1.44	43.70	44.05	44.21	397.5	386.6	388.40	0.74	0.75	0.74
V_3	1.47	1.47	1.46	1.45	1.44	1.45	44.42	44.87	45.02	426.8	413.8	415.70	0.78	0.78	0.77
V_4	1.47	1.47	1.46	1.44	1.43	1.44	38.36	38.16	38.31	263.6	254.8	255.70	0.64	0.66	0.65
S.E. ±	0.005	0.006	0.006	0.010	0.010	0.011	1.19	1.17	1.18	1.81	1.79	1.80	0.02	0.02	0.02
C.D (p=0.05)	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	3.47	3.41	3.43	5.28	5.21	5.23	0.07	0.07	0.07
C x M															
S.E. ±	0.007	0.007	0.007	0.006	0.006	0.006	1.01	0.94	0.94	2.01	2.18	2.23	0.04	0.04	0.04
C.D (p=0.05)	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S	9.38	10.61	10.89	NS	NS	NS
C x V															
S.E. ±	0.008	0.008	0.008	0.014	0.014	0.014	1.56	1.55	1.53	2.51	2.61	2.65	0.04	0.05	0.05
C.D (p=0.05)	N.S.	N.S.	0.030	N.S.	N.S.	N.S.	N.S.	N.S.	N.S	9.06	10.12	10.37	NS	NS	NS
M x V															
S.E. ±	0.009	0.009	0.009	0.013	0.013	0.013	1.69	1.61	1.64	2.75	2.74	2.76	0.04	0.04	0.04
C.D (p=0.05)	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S	9.02	9.00	9.07	NS	NS	NS

paramount factor, determining the microbial biomass activity in soils and the factors such as temperature, pH, moisture content and clay content were withal kenned to affect the microbial biomass in soil (Sharma *et al.*, 2011).

Conservation techniques and Organic carbon (%): Analytically non consequential tillage system and mulching was observed on soil organic carbon (SOC) for three perpetual seasons (Table 3). Maximum SOC was recorded in the mulching @ 4 Mg ha^{-1} conditions. Organic carbon has its own power of engendering astute soil structure with aggregate stability and parallely crop establishment till maturity. Relinquished atmospheric CO_2 due to perpetual ploughing cumulates with other gases to insert green house effect but in conservation tillage left over stubbles on the surface bulwarks the soil and restricts in conversion of plant carbon to SOM and humus, which might be the possible reason for incremented soil organic carbon for conservation tillage plots than conventional plots. Singer *et al.* (2008) abstracted that no-till conserved organic carbon. Organic matters in soil were incremented by straw mulching, (Table 3) which was more evident in the zero tillage (with residue retention) (Yi *et al.*, 2007) was controvertibly caused by less oxidation of organic matter (crop residue) due to less perturbance of soil by tillage (Saha *et al.*, 2010. So the integrated compost proved its competency not only by incremented quantity but withal the quality SOM, thus amending soil quality and productivity (Singh and Dhar, 2011) concluding that the higher amount of vermicompost applied had higher organic matter in soil.

Conservation techniques and establishment induced yield characters: Girth of cob differs significantly for the first two seasons, whereas length of cob for the mid season among conventional and zero tillage systems. Non-consequential results were obtained in 100 seed weight during the seasons. Virtually kindred 100 seed weight was recorded with the progress of the seasons. The mean maximum girth and length of cob was observed in mulched than unmulched treatment. Mulch overpowered unmulched with paramount values for the experimental years (Table 4). Again, seasonal differences among the treatments augment making them more paramount

Table 4: Conservation techniques induced germination and establishment on yield attributing and yield characters of maize.

	Yield attributing characters											
	Girth of Cob (cm)			Length of cob (cm)			100 seed weight (g)			Grain yield (Kg ha^{-1})		
Treatments	**2010**	**2011**	**2012**	**2010**	**2011**	**2012**	**2010**	**2011**	**2012**	**2010**	**2011**	**2012**
Tillage system (C)												
C_1	4.46	4.51	4.29	15.50	16.08	13.61	22.75	22.69	21.56	3305	3364	3358
C_0	4.04	4.03	4.17	13.34	12.60	14.31	20.99	21.14	21.57	3238	3297	3291
S.E. ±	0.01	0.03	0.09	0.46	0.57	0.56	0.81	0.53	0.52	96.0	97.0	220.9
C.D (p=0.05)	0.05	0.19	N.S.	N.S.	3.45	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Mulch levels (M)												
M_1	4.34	4.39	4.39	14.48	15.05	14.69	22.43	22.54	22.19	3458	3465	3471
M_0	4.15	4.15	4.08	14.36	13.64	13.24	21.31	21.29	20.93	3084	3197	3178
S.E. ±	0.28	0.27	0.25	0.43	0.34	0.32	0.53	0.23	0.22	47.0	58.0	70.2
C.D. (p=0.05)	N.S.	N.S.	N.S.	N.S.	1.34	1.24	N.S.	0.88	0.88	183.0	229.0	275.6
Nutrient management (V)												
V_1	4.16	4.21	4.11	14.35	14.24	13.84	21.92	21.92	21.55	3171	3200	3196
V_2	4.32	4.28	4.31	14.90	14.71	14.31	22.37	22.33	21.97	3336	3388	3405
V_3	4.53	4.55	4.51	15.24	15.48	15.07	22.91	23.07	22.70	3646	3763	3762
V_4	3.99	4.04	4.01	13.18	12.94	12.62	20.26	20.36	20.03	2932	2973	2933
S.E. ±	0.15	0.14	0.14	0.94	0.80	0.76	1.06	0.85	0.83	207.0	205.0	188.9
C.D. (p=0.05)	0.43	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	605.9	597.6	551.3
C x M												
S.E. ±	0.28	0.27	0.27	0.63	0.66	0.64	0.97	0.57	0.57	107.0	112.0	231.8
C.D. (p=0.05)	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
C x V												
S.E. ±	0.18	0.17	0.19	1.24	1.13	1.09	1.53	1.16	1.14	271.0	269.0	319.8
C.D. (p=0.05)	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
M x V												
S.E. ±	0.21	0.32	0.31	1.23	1.03	0.98	1.40	1.06	1.04	258.0	257.0	241.7
C.D. (p=0.05)	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

results. During the three years study nutrient supersession by highest dose of vermicompost results best among the different nutrient management amalgamations for both girth and length of cob.

Good germination and sound establishment availed yield attributing characters including grain yield to differ non-significantly among the conservation techniques. Izumi *et al.* (2004) reported that wheat root growth was amended after three consecutive years of no-tillage practice due to the amelioration of the physical properties of the soil the perforation resistance became much auspicious to the root growth in the non-tilled plot. Therefore, in maize the reduction in productivity resulting from the no-tillage practice was amended by alleviating the restraint of root growth (Khurshid *et al.,* 2006).

The ultimate objective of germination and better establishment is to give remuneratively lucrative yield. In case of tillage, zero system varied non-significantly with conventional system. Albeit the differences were non-consequential among the treatments but the performance under zero tillage was more proximate with conventional tillage in the second year of experiment (Table 4). Under subplot, the mean maximum paramount grain yield was observed where mulch was applied compared to unmulched during the years of experimentation respectively. Coalescence of inorganics and organics i.e. recommended dose fertilizer and vermicompost significantly affected grain yield during the years of experimentation. The highest grain yield was recorded with treatments receiving vermicompost @ 10t ha^{-1} in cumulation with 75% recommended dose of fertilizer (RDF) which was at par with treatments receiving vermicompost @ 7.5 t ha^{-1} along with 75% recommended dose of fertilizer followed by vermicompost @ 5 t ha^{-1} along with 75% recommended dose of fertilizer.

Better germination owing to preserved moisture and propitious temperature, with steady supply of essential nutrients during establishment period, in mulching @ 4 Mg ha^{-1}, performed better than un-mulching for both yield attributing and yield characters. Straw mulching incremented 100-seed weight and yield attributing characters and concluded that the effects of full-straw mulching denoting that it might be due to the incremented soil moisture content during the years of experimentation (Yi *et al.,* 2007). The possible reason may be that wheat straw mulches engendered auspicious soil temperature and soil moisture conditions which in turn incremented the dry matter accumulation in plant. Khan and Pervej (2010) are additionally in conformity with it.

A good crop establishment depends on continuous supply of nutrients along with salubrious microbial activity, where both the aspects was taken care of by supplementation from vermicompost resulting in better yield attributing characters and grain yield. It was indicative of the fact that Vermicompost in conjunction with nitrogen, phosphorus, potassium exhibited their role in sundry physiological functions, kinetics of growth regulators within the plant, germination and growth of pollen grains and pollen tubes (Patil and Sheelavantar, 2006).

CONCLUSION

Soil conservation techniques did not have much pronounced effect in consecutive three years of experiment on physical properties of soil but their positive role towards formation of favorable soil micro-climate (temperature, moisture) in long term. Thus the engendered conditions by conservation techniques in turn will boost the germination and further establishment of crop in the light textured acid soils. In this way farming community will not only get the better opportunity to reduce the ill effect of tillage but additionally an enhanced yield, making maize cropping system sustainable.

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