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Effect of natural, organic and inorganic farming methods on soil moisture dynamics and weed dynamics in maize

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Abstract
An investigation was carried out during the *kharif*, 2016 at Agricultural College, Jagtial to study the effect of natural farming on soil moisture dynamics and weed dynamics of maize in comparison with inorganic and organic farming. The available soil moisture determined at fortnightly interval did not differ due to farming methods either in DHM 117 and Aswini. Weed growth in terms of density and dry matter was found to vary in different farming methods but remained same between DHM 117 or Aswini. Initially (30 DAS) lower weed density and dry matter were observed with natural farming (4.49 No. m^{-2} and 1.87 g m^{-2}, respectively) due to straw mulching compared to other methods but later (60 DAS) new flush of weeds emerged which could be controlled by hand weeding in organic and inorganic methods.

Keywords: Maize, soil moisture, weed, natural farming

Introduction
Maize (*Zea mays* L.) is the world's third most important cereal crop after rice and wheat. Maize is grown primarily for grain, fodder, raw material for industries and for diversified products. The initial slow growth, wider spacing and heavy fertilization, invites multiple weed species infestation. (Nagavani and Subbian, 2015) [3]. In India maize ranks 5th in area and 3rd in production and is being cultivated in an area 9.63 M ha^{-1} with the production of 25.89 Mt and productivity of 2689 kg ha^{1}. (*Indiastat.* 2017) [2]. In Telangana State, maize is cultivated in an area of 8.02 lakh ha with a total production of 26.66 lakh tons and productivity of 3231 kg ha^{-1} (*Indiastat.* 2017) [2].

Organic manures are not only supplying plant nutrients but also improve the soil quality indicators *viz*. physical, chemical and biological. Some of the primary effects of use of organic fertilizers are increase in soil organic matter, improved soil properties for crop growth and increase in nutrient status over a longer period of time, increased CEC and improved soil biological activity. The integrated use of organic and inorganic nutrients source is beneficial to enhance soil properties by increasing labile soil carbon fraction and maintain the crop yields as well as also helps in increasing moisture holding capacity of the soil. The increased capacity to hold moisture is especially important under moisture deficit condition with integrated use of organic and inorganic nutrients. (Zari *et al.* 2016) [9].

The retention of crop residues on the soil surface is a key principle for reducing surface water runoff and erosion. A mulch of crop residue enhances water infiltration and protects the soil from sealing and crusting by rainfall. Under semi arid conditions, surface plant residues also play an important role in conservation of soil water through reduced soil evaporation. In addition, crop residues as mulch moderate the temperature fluctuation in the top layer, which can enhance the activity of soil microorganisms and fauna, thus promoting the release of nutrients, improving water infiltration and facilitating root development. The water conservation effect of surface residue may potentially increases crop yields in tropical environment (Priya and Shashidhara, 2016) [4].

Material and Methods
A field experiment was carried out during *kharif*, 2016 at Agricultural College Farm, Jagtial. The experimental soil was sandy clay loam in texture, slightly alkaline in reaction (pH 7.65), low in organic carbon (0.47 per cent) and available nitrogen (164 kg ha^{-1}), high in available phosphorous (43 kg ha^{-1}) and medium in available potassium (277 kg ha^{-1}). The experiment was laid out in randomized block design with factorial concept replicated thrice. Eight treatment combinations were taken *viz*., factor I: Variety vs Hybrid:2, V_1: DHM-117, V_2:Aswini, factor II: Farming methods:4, F_1: Absolute control (no fertilizers, pesticides, herbicides and no hand weeding but only irrigation as and when required), F_2: Natural farming

(Seed treatment with *Beejamrutha* + application of *Jeevamrutha* at fortnightly intervals + mulching with organic residues + plant protection with natural pesticides /fungicides like *Neemasram*, *Agnasram* and *Pullati majjiga*), F_3: Organic farming (FYM @ 20 t ha^{-1} (basal) + Vermicompost @ 5 t ha^{-1} each at knee high stage and tasseling stage (top dressing) + plant protection with organic products) and F_4: Inorganic farming.

Beejamrutha was prepared as per Yogananda Babu (2015) [8] i.e., mixing 5 kg desi cow dung, 5 liters of desi cow urine, 50 g lime and 100 g antennae soil with the 20 liters of water and keep it as such for an overnight. On the day of sowing maize seeds were soaked in the *Beejamrutha* solution and dried in shade condition before sowing of the crop. *Jeevamrutha* was prepared by placing 200 liters of water in a barrel and added 10 kg fresh desi cow dung, 10 liters of desi cow urine, 2 kg each of jaggery and chickpea flour and 100 g of antennae soil. The mixture was fermented for 3 days in shade condition. Mulching was done with the use of paddy straw (8 inch layer) when the crop was at 3-4 leaf stage. *Neemasram* was prepared by mixing of 10 liters of cow urine and Neem (*Azardiracta indica*) leaves in 200 liters of water and fermented for 5 days in shade condition. This fermented solution was applied as anti-repellent in form of spray.

In control treatment there was no weed management. While in Natural faming method, mulch act as weed suppresser. In organic farming method, the weeds were controlled by hand weeding at 10 days interval up to 50 DAS. Pre emergence application of atrazine 50% WP @ 2.0 kg ha^{-1} with hand weeding at 10 and 40 DAS was practiced in inorganic farming method.

Fertilizer management in natural farming through basal application of *Gana jeevamrutha* @ 500 kg ha^{-1} was followed by *jeevamrutha* @ 500 L ha^{-1} along with irrigation water starting from 15 DAS to harvest at 15 days interval. When rainfall occurred, it was sprayed directly on the soil through knapsak sprayer. While in organic farming, FYM was applied basally @ 20 tonnes ha^{-1} and vermicompost was applied @ 10 tonnes ha^{-1} at knee high and tasseling stages and in inorganic farming, a recommended dose of 200:60:50 kg ha^{-1} of $N:P_2O_5:K_2O$ as urea, di ammonium phosphate and murate of potash was applied, respectively. Nitrogen was applied in three equal splits i.e., as basal dose, at knee high and flowering stage. The recommended dose of phosphorous was applied as basal dose. One irrigation was given immediately after sowing for uniform germination. Subsequent irrigations were scheduled depending on the soil moisture content at important phenological stages of crop during rainless periods. A total of 5 irrigations were given to the crop. Soil moisture content (%) was estimated by gravimetric method (Black, 1965) [1] at 15 days interval from sowing to harvest.

$$\text{Soil Moisture (\%)} = \frac{\text{Weight moist soil} - \text{weight of oven dry soil}}{\text{weight of oven dry soil}} \times 100$$

Weed density was recorded by marking an area of one m^2 using quadrant in each net plot, the population of grasses, sedges and broad leaved weeds were recorded at 30 and 60 DAS, the data were statistically analysed after subjecting these values to $\sqrt{(X+1)}$ square root transformation. The weed dry matter was found through removing weeds from one m^2 area using the quadrant from each plot at 30 and 60 DAS. The samples were shade dried and then oven dried at 65 ^{0}C to a constant weight and their dry weights were expressed in g m^{-2}.

Results and Discussion

Soil moisture dynamics

Perusal of the data indicates that soil moisture did not change due to the cultivation of hybrid or variety throughout the growth period of maize. Similarly, there was no significant change in soil moisture with different farming methods at all the observations even though a little higher percentage of moisture was recorded with natural farming method (Table 1). Ramakrishna *et al*. (2006) [5] and Uwah and Iwo (2011) [7] reported that straw mulching improved the soil moisture status which is in contrary to the finding in the present investigation wherein the soil moisture status was not improved in natural farming method due to straw mulching. The reason attributed is due to well distributed rainfall throughout the growth period of maize as the experiment was conducted during *kharif* season.

Weed dynamics

Weed density

Weed growth in terms of weed density (No. m^{-2}) was found to differ in different farming methods but not influenced by variety/hybrid or the interaction of the two factors. At 30 DAS, highest weed density was recorded in control, followed by organic farming method (Table 2). Significantly lower weed density was found in natural farming method compared to organic method but at par with inorganic method. At 60 DAS significantly lower weed density was observed in inorganic method compared to natural farming but at par with organic method. The reason for lower weed density in natural method of farming at 30 DAS is attributed to suppression of weeds by straw mulching. But at 60 DAS, due to hand weeding in inorganic method, the weeds were efficiently controlled over mulching done in natural method.

Weed dry matter

It was influenced by farming method but not by variety/hybrid or their interaction at 30 and 60 DAS (Table 2). Both at 30 and 60 DAS, highest weed dry matter was recorded in absolute control while the lowest was recorded in natural farming method which was significantly lower to the other two methods. Inorganic method was superior to organic method at 60 DAS but both were at par at 30 DAS (Table 2). Overall, it can be inferred from the observation on weeds that weed growth was significantly reduced in natural farming method compared to other two methods due to weed suppression by mulching of paddy straw. However, higher number of weeds at 60 DAS in this method might be due to emergence of small weeds in new flush which cannot offer competition to maize plants which will close the inter row spaces by 60 DAS. Sangakkara *et al.* (2012) [6] also reported that weed growth in maize was significantly reduced with mulching in natural farming. The findings of Ramakrishna *et al.* (2006) [5] and Uwah and Iwo (2011) [7] also confirm the positive effects of straw mulching on weed suppression in groundnut and maize, respectively. This might be due to the fact that thick mulch layers reduce the availability of solar radiation to the germinating weeds and affecting their growth.

Finally in can be concluded that soil moisture dynamics not influenced by either variety/hybrid nor farming methods. The weed dynamics (density and dry matter) were recorded lower in natural farming methods during initial stages (30 DAS) and at later stages organic and inorganic methods recorded lower weed dynamics.

Table 1: Available soil moisture as influenced by different farming methods

Treatment	Available soil moisture (%)						
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	Harvest
Variety Vs hybrid							
DHM 117	12.76	16.14	9.78	14.32	13.43	13.97	12.27
Aswini	12.63	15.47	9.67	14.79	13.50	13.35	12.12
S.Em±	0.35	0.41	0.46	0.36	0.68	0.51	0.36
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS
Farming method							
Absolute control	12.80	15.57	9.30	14.15	12.94	13.97	11.46
Natural farming	12.75	16.00	10.30	15.75	14.56	13.74	13.07
Organic farming	12.70	15.83	9.95	14.70	13.89	14.66	12.07
Inorganic farming	12.52	15.82	9.34	13.62	12.47	12.28	12.18
S.Em±	0.50	0.58	0.65	0.51	0.96	0.72	0.51
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS
Interaction							
S.Em±	0.71	0.82	0.92	0.72	1.36	1.02	0.72
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS
CV (%)	9.67	8.97	16.41	8.51	17.47	12.88	10.26

Table 2: Weed dynamics in maize as influenced by different farming methods

Treatment	Weed density (No. m^{-2})		Weed dry matter (g m^{-2})	
	30 DAS	60 DAS	30 DAS	60 DAS
Variety Vs hybrid				
DHM 117	6.75 (51.50)	6.55 (45.21)	3.69 (16.67)	5.31 (33.34)
Aswini	6.06 (39.83)	6.65 (46.13)	3.85 (17.33)	5.62 (37.92)
S.Em±	0.31	0.30	0.15	0.17
CD (P = 0.05)	NS	NS	NS	NS
Farming method				
Absolute control	9.28 (88.33)	8.47 (71.92)	6.20 (38.75)	7.96 (64.67)
Natural farming	4.49 (22.17)	6.42 (41.33)	1.87 (3.88)	1.73 (3.17)
Organic farming	6.43 (43.33)	6.16 (38.08)	3.84 (14.87)	6.61 (43.72)
Inorganic farming	5.43 (29.83)	5.34 (31.33)	3.17 (10.10)	5.55 (30.97)
S.Em±	0.44	0.42	0.22	0.24
CD (P = 0.05)	1.35	1.29	0.66	0.72
Interaction				
S.Em±	0.63	0.60	0.31	0.34
CD (P = 0.05)	NS	NS	NS	NS
CV (%)	17.01	15.74	14.06	10.71

Note: 1. Figures in the parentheses are the original values

2. Data subjected $\sqrt{(X+1)}$ transformation

3. Weed data collected before hand weeding in organic and inorganic farming methods

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