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EFFECT OF SOP, FYM AND WHEAT STRAW ON LEAF AND SOIL MOISTURE CONTENTS UNDER KHARIF MAIZE, *Zea mays*

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ABSTRACT

The efficiency of SOP, FYM (farmyard manure) and wheat straw was studied on two maize varieties viz., EV-1098 and EV-3001 at Agronomic Research Farm of University of Arid Agriculture, Rawalpindi in 2003. All the organic and inorganic constituents were thoroughly mixed in the soil 15 days before sowing. The treatments comprised, control, FYM (3 t ha^{-1}), wheat straw (3 t ha^{-1}), SOP (60 kg ha^{-1}), FYM + wheat straw (1.5 t each ha^{-1}), FYM (1.5 t)+ SOP (30 kg ha^{-1}), wheat straw (1.5 t)+ SOP (30 kg ha^{-1}), FYM + wheat straw (1 teach) + SOP (20 kg ha^{-1}). The statistical analysis of data for soil moisture content and leaf moisture content at three different stages showed significant differences among different manuring treatments. However, the highest soil moisture in both the varieties was observed in treatment having high doses of FYM followed by the FYM mixed with other fertilizers.

Key Words: Maize, potash, wheat straw, FYM, soil and plant moisture content

INTRODUCTION

Maize (*Zea mays.* L) is one of the four principal food crops of the world and has great promise for high yield and easy cultivation than any other cereal. The nitrogen and phosphorus resources in almost all the soils have decreased. Potassium is also limited to certain extent in some soils. The adequate supply of plant nutrients and water management in crop production has therefore, assumed the foremost importance in profitable agriculture in the region (Saeed, 1994). Efforts for years have been made to improve crop yields through proper soil fertility and water management under rainfed conditions.

Potassium is of utmost importance for water status of plant, regulates opening and closing of stomata and translocation of photosynthates (Mengel and Kirkby, 1987). Within any one of the selected soils, the highest soil moisture is conserved with FYM followed by FYM mixed with other fertilizer (Nizami and Salim, 1995).

Animal manure has long been used as an organic source of plant nutrients and organic matter to improve the physical conditions and fertility of agricultural lands. Much of land applied manure is surface-broadcasted or incorporated to a shallow depth of field under crop residues and conservation tillage management because of the need to conserve stored soil water for crop production (Schwartz *et al.*, 2002).

Therefore in the present investigation efforts has been made to study the comparative effect of SOP, FYM and wheat straw incorporation in soil, on leaf and soil moisture content at different stages of plant growth to suggest better combination ratio of all these inputs for maize production.

MATERIALS AND METHODS

Two maize varieties viz., Var. EV-1098 and EV- 3001 were planted in randomized complete block design having split plot arrangement under rainfed condition at the seed rate of 30 kg ha^{-1}. The row-to-row and plant-to-plant distance was maintained at 75 cm and 25 cm, respectively. A basal dose of nitrogen and phosphorous was applied in all plots at the rate of 90 kg ha^{-1} each. Farmyard manure, wheat straw and potassium sulphate was incorporated in soil 15 days before sowing in the combinations, control, FYM (3 t ha^{-1}), wheat straw (3 t ha^{-1}), SOP (60 kg ha^{-1}), FYM + wheat straw (1.5 t each ha^{-1}), FYM (1.5 t)+ SOP (30 kg ha^{-1}), wheat straw (1.5 t)+ SOP (30 kg ha^{-1}), FYM + wheat straw (1 teach) + SOP (20 kg ha^{-1}). The sub plot size was 3m x 3.5m. Soil moisture content (%) at 15, 30, 45, 60, 75 and 90 days after sowing (DAS) and leaf moisture content (%) at tasseling, silking and grain filling was taken.

For measuring soil moisture content, three soil samples were taken from each plot at a depth of 0-15 cm with the help of auger fortnightly from sowing till the harvest of crop. For plant moisture content leaf lamina of upper three leaves of three plants from each plot were taken. Soil and plant moisture content was determined by common oven dried formula.

$$\text{Moisture content (\%)} = \frac{\text{Fresh weight - oven dry weight}}{\text{Oven dry weight}} \times 100$$

The data was analyzed and the Least Significant Differences test was applied to compare the treatment means.

RESULTS AND DISCUSSION

Soil moisture content at 15 DAS

Statistical analysis of data showed significant difference among manuring treatments but the varieties were unable to show significant difference. Interaction between varieties and treatments was also non significant. The highest, soil moisture (15%) was conserved by FYM + wheat straw (1 t each) + SOP (20 kg ha^{-1}) which was at par with 1.5 t FYM + 30 kg SOP ha^{-1} whereas the lowest (13.16 %) being in 1.5 t wheat straw + SOP 30 kg ha^{-1} which was at par with 60 kg SOP ha^{-1} and control. The plots fertilized with 3 t FYM and 3 t wheat straw showed statistically same moisture level. Incorporation of SOP alone and in combination with wheat straw in the soil did not significantly increased moisture content against control (Table 1). It indicates comparatively more soil moisture utilization by growing crop in the chemical fertilizer treatment (Nobel, 1983).

Soil moisture content at 30 DAS

Mean values of data indicated that there was a significant difference among the different manuring treatments whereas varieties failed to bring about significant difference (Table 1). Interaction between varieties and treatments was also non significant. 1 t FYM + wheat straw each + 20 SOP kg ha^{-1} conserved the highest soil moisture followed by 3 t FYM ha^{-1} and 1.5 t FYM + wheat straw ha^{-1} and the lowest value for moisture content was shown by 60 kg SOP ha^{-1} which was at par with control. FYM and wheat straw alone did not show significant difference among themselves. SOP alone did not prove effective but when applied in combination with FYM and wheat straw more moisture was retained in soil. Plot receiving SOP in combination with FYM and wheat straw conserved more moisture at 30 days after sowing. So the highest soil moisture is conserved with FYM followed by FYM mixed with other fertilizer (Nizami and Salim, 1995).

Soil moisture content at 45 DAS

Mean values of data showed that statistically there was a significant difference among the different manuring treatments whereas varieties have shown non significant Interaction between varieties and treatments was also non significant results (Table 2). Available moisture at 45 DAS after sowing was quite less in all the plots than 15 and 30 DAS because total rainfall received during this period was low (95.9 mm). Mean values indicated that moisture content ranged from 9.50 to 11.84 %. The maximum value for moisture content was observed in the treatment 1 t FYM + wheat straw each + 20 kg SOP ha^{-1} which was at par with treatment 3 t wheat straw ha^{-1} and 1.5 t FYM + wheat straw ha^{-1} each. The lowest value being in control plots which was at par with 60 kg SOP ha^{-1}. So plots receiving higher doses of straw conserved more moisture content. It may be due to full decomposition of wheat straw at this stage which retained more moisture due to increased water holding capacity of soil and improved soil structure.

Soil moisture content at 60 DAS

Mean values of data revealed that there was a significant difference among the different manuring treatments whereas varieties showed non significant results and interaction between varieties and manuring treatments was also non significant (Table 2). The highest soil moisture was conserved by 1 t FYM + wheat straw each + 20 kg SOP ha^{-1} followed by 1.5 t FYM + wheat straw ha^{-1} each and the lowest value for moisture content was shown by 1.5 t wheat straw + 30 kg SOP ha^{-1}, which was at par with 60 kg SOP ha^{-1} and control. FYM and wheat straw alone retained statistically same moisture which was significantly higher than control plots. FYM alone and in combination with SOP imparted better effect for moisture conservation compared with wheat straw. The results match with findings of (Nizami and Salim, 1996) who observed highest soil moisture conservation by application of 10 t FYM followed by 5 t FYM + Chemical fertilizer.

Soil moisture content at 75 DAS

Mean values of data indicate that there was a significant difference among the different manuring treatments whereas varieties responded non significantly for moisture conservation. Interaction between varieties and

treatments was also non significant (Table 3). Treatment 1.5 t FYM + wheat straw ha^{-1} each gave the highest value for moisture content which was at par with 1 t FYM + wheat straw each + 20 kg SOP ha^{-1}. The reason for low moisture at this stage could be due to evaporation losses as only 116.3 mm rainfall received during this fortnight and last rainfall was 66.5 mm received 4 days before soil sampling. FYM and wheat straw alone and in combination showed non significant difference among themselves. SOP alone and in combination with FYM and wheat straw conserved significantly higher moisture than control.

Soil moisture content at 90 DAS

Analysis of data revealed that both varieties and manuring brought significant differences in various treatments of the experiment for soil moisture content at this stage whereas interaction between varieties and treatment was non significant (Table 3). Mean values showed that highest moisture was conserved by 1.5 t FYM + wheat straw ha^{-1} each followed by the treatments 1 t FYM + wheat straw ha^{-1} each + 20 SOP Kg and 3 t wheat straw ha^{-1}, the lowest value for moisture content was shown by control plots. Variety EV-1098 conserved significantly higher (6.47%) moisture than EV-3001 (6.21%). The reason may be due to difference in stomatal size and number in both the varieties.

Leaf Moisture content at tasseling

Data on leaf moisture content at tasseling is shown in Table 5. Statistical analysis of the data showed that leaf moisture content at this stage was significantly affected by manuring treatments whereas both varieties and interaction between varieties and treatments have shown non significant results (Table 4,5).

Table 1. Soil moisture content affected by different manuring and varieties in maize at 15 and 30 DAS.

Treatments	15 DAS			30 DAS		
	V1	V2	Means	V1	V2	Means
Control	13.94	12.86	13.40c	14.07	12.42	13.25bc
3 t FYM ha^{-1}	14.15	15.01	14.53ab	14.30	14.17	14.24ab
3 t wheat straw ha^{-1}	13.97	13.11	13.54bc	13.97	13.55	13.77bc
60 kg SOP ha^{-1}	13.66	12.96	13.31c	13.44	12.70	13.07c
1.5 t FYM + wheat straw each ha^{-1}	13.98	14.43	14.21abc	14.38	14.08	14.23ab
1.5 t FYM + 30 kg SOP ha^{-1}	15.34	14.40	14.87a	14.39	13.75	14.07abc
1.5 t wheat straw + 30 kg SOP ha^{-1}	13.27	13.05	13.16c	14.23	13.66	13.95abc
1 t FYM + wheat straw each + 20 kg SOP ha^{-1}	14.52	15.47	14.97a	15.29	14.72	15.01a
Means	14.09	13.91		14.26	13.63	
LSD	1.061			1.08		

Any two means in a column not sharing a letter differ significantly at 5% level of probability.

It is inferred from the data that the highest leaf moisture was observed in the treatment with 1.5 t wheat straw + SOP 30 kg ha^{-1} which was at par with 1.5 t FYM + SOP 30 kg ha^{-1} and SOP 60 kg ha^{-1} and the minimum value was given by control plots. SOP and straw incorporation proved helpful for increased leaf moisture at this stage. Leaf moisture content in Var. EV-3001 was significantly higher than var. EV-1098 at this stage. Treatment having SOP retained more moisture in leaves as it helps in retention of water in plant tissues (Kemmelar and Krauss, 1989). FYM gave higher value of leaf moisture retention compared with wheat straw.

Leaf Moisture content at Silking

Analysis of the data indicated that leaf moisture content at this stage was significantly affected by manuring treatments whereas both varieties and also the interaction between varieties failed to bring about significant changes. Treatments with 60 kg SOP ha^{-1} have shown the highest value of leaf moisture content 263.51% followed by 1.5 t FYM + SOP each ha^{-1} at this stage and the lowest value was observed in control plots. The result are in conformity with Kemmelar and Krauss (1989) who stated that K fertilization besides increasing dry matter production and leaf area development, greatly improve the retention of water in the plant tissues even under severe water stress. FYM

and wheat straw alone did not show significant difference among them but in combination with SOP, FYM gave more value of leaf moisture content compared with wheat straw (Table 4).

Table 2. Soil moisture content affected by different manuring and varieties in maize at 45 and 60 DAS.

Treatments	45 DAS			60 DAS		
	V1	V2	Means	V1	V2	Means
Control	9.59	9.42	9.50e	7.273	8.637	7.955c
3 t FYM ha^{-1}	10.46	10.66	10.56cd	8.913	8.863	8.888ab
3 t wheat straw ha^{-1}	11.41	12.00	11.70ab	8.507	8.543	8.525b
60 kg SOP ha^{-1}	10.27	9.47	9.87de	8.117	7.830	7.973c
1.5 t FYM + wheat straw each ha^{-1}	10.77	11.33	11.05abc	8.980	9.157	9.068a
1.5 t FYM + 30 kg SOP ha^{-1}	11.07	10.43	10.75bcd	8.260	8.337	8.798ab
1.5 t wheat straw + 30 kg SOP ha^{-1}	11.30	10.33	10.31cde	7.810	7.260	7.535c
1 t FYM + wheat straw each + 20 kg SOP ha^{-1}	11.75	11.94	11.84a	9.347	9.022	9.184a
Means	10.70	10.70		8.526	8.456	
LSD	0.963			0.515		

Any two means in a column not sharing a letter differ significantly at 5% level of probability.

Table 3. Soil moisture content affected by different manuring and varieties in maize at 75 and 90 DAS.

Treatments	75 DAS			90 DAS		
	V1	V2	Means	V1	V2	Means
Control	6.39	6.10	6.25 c	5.84	5.49	5.67 e
3 t FYM ha^{-1}	7.23	6.97	7.10 b	6.58	6.06	6.33 bc
3 t wheat straw ha^{-1}	7.00	6.85	6.92 b	6.69	6.63	6.66 b
60 kg SOP ha^{-1}	6.88	6.90	6.89 b	6.56	5.85	5.21 cd
1.5 t FYM + wheat straw each ha^{-1}	7.87	7.55	7.71 a	7.24	6.92	7.08 a
1.5 t FYM + 30 kg SOP ha^{-1}	6.79	6.60	6.70 b	5.90	5.73	5.82 de
1.5 t wheat straw + 30 kg SOP ha^{-1}	7.09	6.81	6.95 b	6.24	6.41	6.32 bc
1 t FYM + wheat straw each + 20 kg SOP ha^{-1}	7.37	7.05	7.21 ab	6.73	6.59	6.66 b
Means	7.08	6.85		6.47	6.21	
LSD	.56			For var: 0.25 Tret:0 .41		

Any two means in a column not sharing a letter differ significantly at 5% level of probability.

Leaf Moisture content at grain filling stage.

Analysis of data revealed that both varieties and manuring brought significant differences in various treatments of the experiment for leaf moisture content at this stage. The maximum leaf moisture was observed in treatments having 1.5 t wheat straw + SOP 30 kg ha^{-1} which was at par with 1.5 t FYM + wheat straw each ha^{-1} and 1.5 t FYM + SOP 30 kg ha^{-1}. FYM and wheat straw alone show higher leaf moisture values but wheat straw could not reach the level of significance. So treatments having combination of SOP and straw incorporation proved helpful for increased leaf moisture at this stage. It might be because of potassium present within plants as the cation K^+, plays an important role in regulation of the osmotic potential of plant cells. It activates enzymes involved in manufacturing of photosythates in plant leaves indicating high leaf moisture content (Lincolin and Zeiger, 2002). Leaf moisture content in Var. EV-3001 was significantly higher than var. EV-1098 at this stage (Table 4).

As soil and leaf moisture content vary in both the varieties in spite of there varietal differences, some other factors played role as number of stomata or stomatal size in leaf laminna. So further research is needed to conclude which variety performs better in terms of moisture usage. Moreover, and study on transpiration would also be useful in this regard.

CONCLUSION

It can be concluded from the experiment that incorporation of FYM wheat straw and potassium when used in combination helped to conserve soil moisture. Application of potassium fertilizer in combination with FYM and wheat straw increased leaf moisture content.

Table 4. Leaf moisture content affected by different manuring and varieties at tasseling and silking stage in maize.

Treatments	At Tasseling			At Silking		
	V1	V2	Means	V1	V2	Means
Control	239.9	226.9	233.4c	193.33	195.6	194.46 h
3 t FYM ha^{-1}	224.1	245.5	234.8c	218.63	223.66	220.85e
3 t wheat straw ha^{-1}	222.4	270.2	246.3bc	195.03	204.93	200.6g
60 kg SOP ha^{-1}	262.8	278.8	270.8ab	260.30	266.73	263.51a
1.5 t FYM + wheat straw each ha^{-1}	211.9	244.3	228.1c	206.33	209.33	207.83f
1.5 t FYM + 30 kg SOP ha^{-1}	275.4	270.4	272.9ab	247.80	262.50	255.15b
1.5 t wheat straw + 30 kg SOP ha^{-1}	280.1	283.6	281.9a	227.66	232.73	230.20d
1 t FYM + wheat straw each + 20 kg SOP ha^{-1}	240.1	220.7	230.4c	237.33	249.06	243.20c
Means	244.6	255.1		223.43	230.52	
LSD	28.3			23.24		

Any two means in a column not sharing a letter differ significantly at 5% level of probability.

Table 5. Leaf moisture content affected by different manuring and varieties at maturity in maize.

Treatments	At Maturity		
	V1	V2	Means
Control	49.5	48.7	49.1c
3 t FYM ha^{-1}	52.6	66.0	59.3b
3 t wheat straw ha^{-1}	49.9	62.0	56.0bc
60 kg SOP ha^{-1}	47.8	60.5	54.2bc
1.5 t FYM + wheat straw each ha^{-1}	71.8	73.2	72.5a
1.5 t FYM + 30 kg SOP ha^{-1}	60.0	78.2	69.1a
1.5 t wheat straw + 30 kg SOP ha^{-1}	67.56	81.6	74.6a
1 t FYM + wheat straw each + 20 kg SOP ha^{-1}	51.7	59.1	55.4bc
Means	56.4b	66.2a	
LSD	For manuring: 9.7, Varieties: 8.44		

Any two means in a column not sharing a letter differ significantly at 5% level of probability.
DAS: Days after sowing

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