International Journal of Agricultural Engineering, Vol. 2 No. 2 (October 2009 to March 2010) : 322-328

Research Paper :

Effect of organic mulches on soil moisture conservation and yield of *rabi* sorghum (M-35-1)

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Accepted : *September, 2009*

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ABSTRACT

The study was conducted at College of Agricultural Engineering and Technology, Marathwada Agricultural University, Parbhani during the year 2001-2002 in Randomized Block Design with five mulching treatments and four replications. The size of each plot was 6m X 4.5 m. Topography of the experimental plot was uniform and leveled. Parbhani has sub tropical climate with an average annual rainfall of 850 mm. The total soil moisture depletion from sowing to harvest at 15 cm, 30 cm and 45 cm soil depths was 9.14 %, 11.33 % and 11.92 %, respectively in *rabi* sorghum. Percentage increase in soil moisture in sugarcane trash mulch, wheat straw mulch, soybean straw mulch and interculturing operation over control (no mulch) was 28.19 %, 17.81 %, 12.26 % and 7.54 %, respectively. Average soil temperature observed in sugarcane trash mulch, wheat straw mulch, soybean straw mulch, Interculturing operation and Control (no mulch) was 19.58^{0}C, 20.04^{0}C, 20.37^{0}C, 20.73^{0}C and 21.33^{0}C, respectively. Increase in grain yield in sugarcane trash mulch, wheat straw mulch, soybean straw mulch and interculturing operation over control (no mulch) was 12.64 %, 9.06 %, 7.46 % and 3.74 %, respectively.

Key words : Organic mulch, Soil moisture, soil temperature and Grain yields.

Water is the most limiting natural resource in arid and semi-arid areas for the economic development of the country. In most of the areas the only water available is the rain that falls on the area, hence, for successful agriculture, proper utilization of water is very essential which means to increase the water use efficiency of a crop by adopting suitable water conservation measures. The water loss takes place in nature due to evaporation, transpiration and percolation. The percolation losses can be avoided by applying water to the plants properly. The evaporation loss may be minimized by the use of mulches, such as crop wastes, polythene plastics and chemicals. The transpiration losses can also be minimized to some extents by erecting tunnels over the crops.

Proper utilization of water is essential particularly in arid and semi arid areas. Mulching is an application of any plant residues or other materials for covering top soil surface for conserving soil moisture, reducing the runoff and thereby to control soil erosion, checking weed growth, improving soil temperature, modifying the micro environment of soil to meet the needs of seeds for their good germination and better growth of seedlings.

Irrigation water become scares in summer, which is a serious problem in these arid and semi arid areas. Many a times farmers loose the entire crop in *rabi* and summer season. A large scarcity areas exist in Maharashtra state. It is, therefore, necessary to minimize losses due to evaporation and transpiration to conserve the soil moisture. Evaporation is mainly due to the degree of saturation of soil surface, temperature of air and soil humidity and wind velocity. Several of these factors are greatly influenced only by vegetative cover. Therefore, to conserve the moisture in soil under such conditions, the effective way is to spread the mulches over the crop area or to erect the plastic tunnels over the crop. However, the farmers of this region are not adopting this mulch farming, which may be due to their lack of knowledge and / or may be due to insufficient research work done on the efficiency of the mulches and tunnels in increasing the water use efficiency.

METHODOLOGY

The study was conducted at College of Agricultural Engineering and Technology, Marathwada Agricultural University, Parbhani during the year 2001-2002 in Randomized Block Design with five mulching treatments and four replications. The total size of the experimental field was 26.7 m x 26.1 m. Whole plot was divided in to twenty plots and the size of each plot was 6 x 4.5 m. Topography of the experimental plot was uniform and leveled. The soil of the experimental plot was well drained with 75 cm depth. Parbhani has sub tropical climate with an average annual rainfall of 850 mm. The data in respect of physical and chemical properties of soil are given in

Table 1. *Rabi* sorghum variety (M-35-1) Maldandi was sown with the spacing of 45 cm x 20 cm by the drilling machine. The organic mulching treatments used were sugarcane trash mulch, wheat straw mulch, soybean straw mulch, interculturing operation and Control (no mulch). The plan of field layout and treatment details along with symbols used are given in Table 2 and other details of the experiments are as follows.

- Total number of treatments = 5
- Number of replications = 4
- Number of total plots = 20
- Plot size = 6 m x 4.5 m
- Sowing method = Drilling
- Soil type = Clayey
- Average soil depth = 75 cm
- Average slope = 1 % (East to West direction)
- Crop = *Rabi* sorghum
- Variety = M-35-1 (Maldandi)
- Date of sowing = 29.10.2001
- Interculturing operations
  a. Hoeing with blade hoe = 2
  b. Hand weeding = 1
- Spacing = 45 cm x 20 cm
  (Row to row and plant to plant)
- Date of harvest = 20.03.2002

These organic mulches were spread @ 5 tonnes per hectare over the experimental plots 15 days after sowing of sorghum crop. Not a single irrigation was given to the crop during its growing period; observations like soil moisture, soil temperature, biometric observations and yield of crop were recorded during the whole experimental period.

Table 1 : Physical and chemical properties of soil from the experimental field

Sr. No.	Constituents	Value
1.	Physical/mechanical composition	
	Sand (%)	12 %
	Silt (%)	24 %
	Clay (%)	52 %
2.	Texture	Clayey
3.	Bulk density	1.32 mg/m^3
4.	Infiltration rate	18 mm/ hr
5.	Hydraulic conductivity	9mm/hr
6.	Field capacity	36%
7.	Pwp	17%
8.	PH2	8.61
9.	Ece	4.06dsm^{-1}
10.	Organic carbon	0.57%
11.	Available P_2O_5	16.96 kg/hr
12.	Esp	14.7

Table 2 : Treatment details with symbol used

Sr. No.	Treatment details	Symbols	No. of replications
1.	Sugarcane trash mulch	M_1	04
2.	Wheat straw mulch	M_2	04
3.	Soybean straw mulch	M_3	04
4.	Interculturing operation	M_4	04
5.	Control (no mulch)	M_5	04

The observations of soil moisture, soil temperature and biometric observations are taken from each experimental plots from the depth of 15 cm up to 30 days after sowing and 15 cm, 30 cm up to 60 days after sowing and 15 cm, 30 cm and 45 cm depth after 60 days up to harvesting of the crop. Effect of various mulches on yield of *rabi* sorghum was studied, after harvesting of sorghum earheads from different treatment plots were collected separately and dried for 5 days in order to reduce the moisture content of grain. These earheads were threshed with the help of power thresher, weight of grains was taken and statistical analysis was done. From the data in which the treatment effects were significant, the appropriate standard errors (SE) and critical difference (CD) at 5 % level of probability were calculated for comparison. Soil moisture content was calculated by Gravimetric method using following formula:

$$\text{Moisture conent (\%)} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Final weight}} \times 100$$

Water use:

With the help of initial and final storage of soil moisture in given depth and effective rainfall, total moisture use by crop were calculated by using following formula:

$$\text{Water use (cm)} = \frac{M_1 - M_2}{100} \times \text{Asi (BD)} \times \text{Di} \qquad (2)$$

where,

M_1 = Initial soil moisture (%)

M_2 = Subsequent soil moisture (%)

Asi = Apparent specific gravity (Bulk density) which is 1.32 mg / m^3 for 30 cm depth of soil

Di = Depth of soil sample taken (cm)

Water use efficiency for grain (kg/cm/ha):

The water use efficiency of grain was calculated by using the following formula.

$$\text{WUE} = \frac{\text{Grain yield (kg)}}{\text{Soil moisture used (cm / ha)} + \text{Effective rainfall (mm)}} \qquad (3)$$

RESULTS AND DISCUSSION

The results obained from the present investigation are discussed below :

Plant height:

Field trials were conducted for the study and detailed results of this investigation were analysed for growth attributes *viz.*, plant height and number of functional leaves per plant recorded periodically during crop growth. The plant height indicated vigor and growth of the plant and the data pertaining to mean plant height as influenced periodically by different treatments are presented in Table 3 and depicted in Fig.1.

The plant height on the 30, 45, 60, 75, 90,105 days after sowing and at harvest was 18.104, 35.905, 69.334, 138.192, 155.838, 163.158 and 172.776 cms, respectively. The height of plants was found to increase with advancement in age of the *rabi* sorghum crop till harvest. The mean height recorded periodically during crop growth due to application of sugarcane trash mulch @ 5 t/ha over control was significantly more. The best performance of sugarcane trash mulch on plant height owed the enhancement of early growth than other mulching treatments. The wheat straw mulch on plant height showed better performance than soybean straw mulch, interculturing operation and control (no mulch) but, less than sugarcane trash mulch.

Mean number of functional leaves:

Data pertaining to the mean number of functional leaves per plant as influenced periodically by different treatments are presented in Table 4. and graphically depicted in Fig.2. The mean functional leaves per plant at 30, 45, 60, 75, 90, 105 days after sowing and at harvest

Table 3 : Height of plants (cm) as influenced by various treatments

Treatments	Days after sowing						
	30	45	60	75	90	105	At harvest
M1	19.35	44.00	90.80	182.90	187.90	190.97	198.04
M2	19.20	38.00	86.87	163.60	166.50	172.27	176.26
M3	17.98	35.90	68.70	152.30	160.54	167.54	174.66
M4	17.65	34.60	68.60	131.30	154.65	161.65	167.66
M5	16.34	27.02	31.70	60.86	109.60	123.36	147.26
General mean	18.104	35.905	69.334	138.192	155.838	163.158	172.776

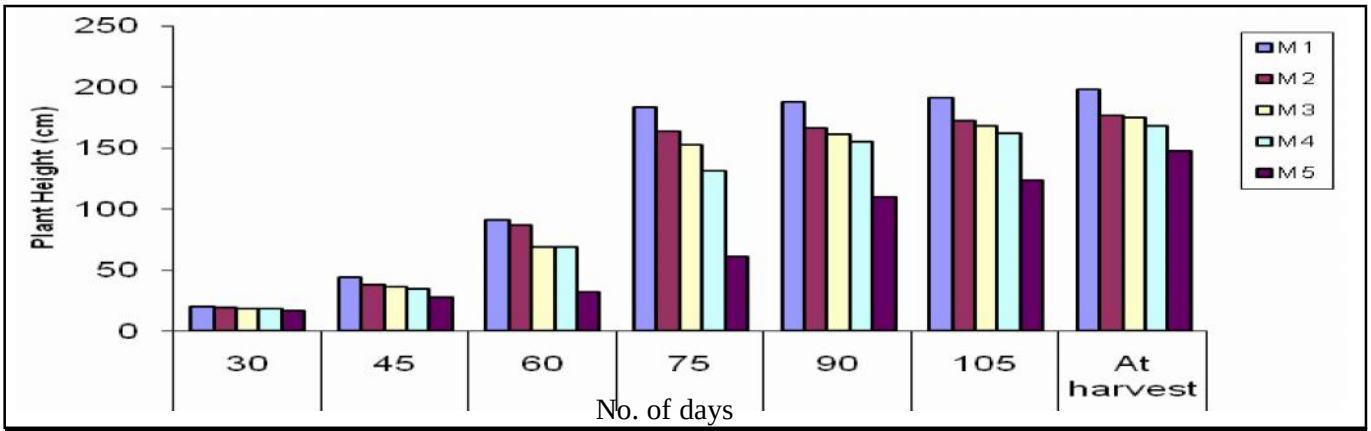

Fig. 1 : Height of plants (cm) influenced by various mulching treatments

Table 4 : Mean number of functional leaves as influenced by various treatments

Treatments	Days after sowing						
	30	45	60	75	90	105	At harvest
M1	3.60	4.06	4.93	6.20	5.00	4.60	3.93
M2	3.55	3.70	4.53	5.90	4.73	4.40	3.60
M3	3.50	3.63	4.37	5.83	4.60	4.20	3.00
M5	3.46	3.60	4.30	5.43	4.47	4.03	2.71
M5	3.30	3.42	3.50	4.40	4.27	4.00	2.53
General mean	3.48	3.68	4.32	5.55	4.61	4.24	3.16

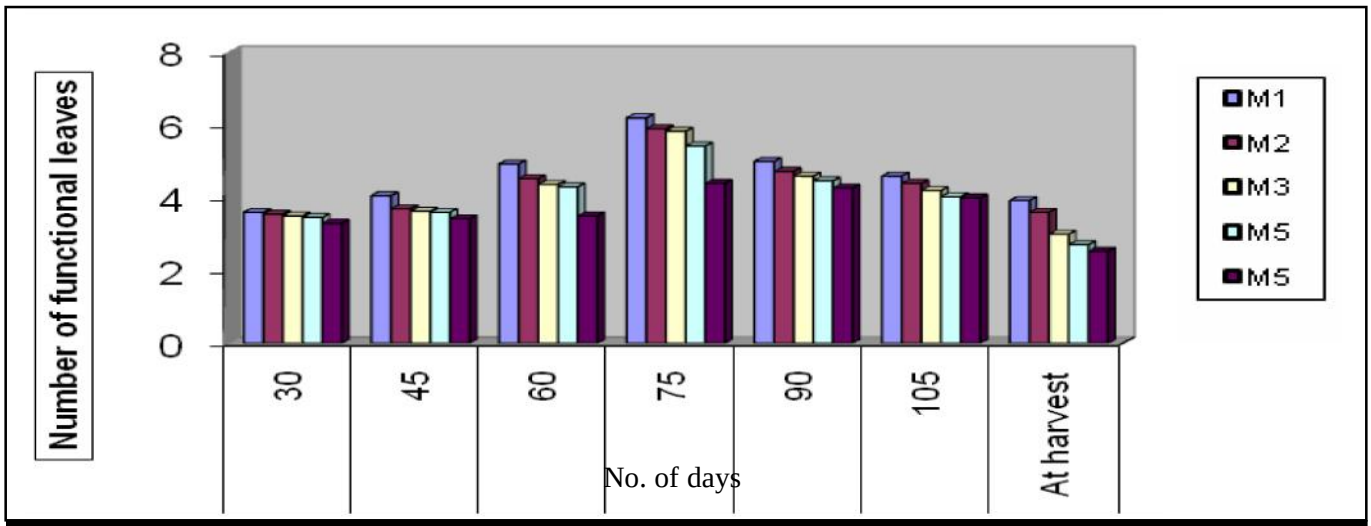

Fig. 2 : Mean number of functional leaves as influenced by various mulching

were 3.48, 4.32, 5.55, 4.61, 4.24 and 3.16, respectively. It was observed from the data that the mean number of functional leaves per plant increased with advancement in the age at 30 to 75 days after sowing and decreased at 75 days till harvest. Sugarcane trash mulch produced significantly higher mean number of functional leaves over other mulch treatments throughout crop growing period.

Soil moisture:

Data regarding soil moisture are presented in the Table 5 and graphically depicted in Fig. 3. The total soil moisture depletion from sowing to harvest from 15 cm, 30 cm and 45 cm soil depth was 9.14 %, 11.33 % and 11.92 %, respectively in *rabi* sorghum. In general the soil moisture depletion was faster during first 15 days and grain filling stage. This may be due to higher atmospheric temperature during first 15 days and at grain filling stage.

The moisture depletion was very slow during 90 days after sowing to at harvest. Soil moisture conservation in sugarcane trash mulch was higher than the other treatments and soil moisture conservation was significant from the time of sowing to the time of harvesting. Average soil moisture at 15 cm, 30 cm and 45 cm depths were

Table 5 : Total soil moisture conserved in various treatments

Treatments	Soil moisture (%)			Average soil moisture (%)
	15 cm	30 cm	45 cm	
M_1	11.10	12.75	12.86	12.23
M_2	9.53	11.59	12.62	11.24
M_3	8.97	11.19	11.99	10.71
M_4	8.37	10.85	11.58	10.26
M_5	7.76	10.29	10.59	9.54
Mean	9.14	11.33	11.92	---------

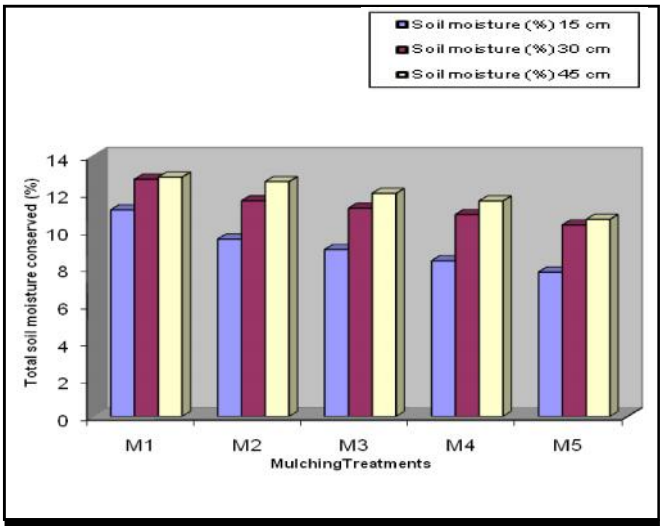

Fig. 3 : Total soil moisutre conserved in various mulching treatments

9.14 %, 11.33 % and 11.92 %, respectively. The average soil moisture conserved in sugarcane trash mulch was more than the other mulches.

Percentage soil moisture increase over Control (no mulch):

The percentage soil moisture increase over Control (no mulch) are presented in Table 6. The values of the percentage soil moisture increased were 12.23 %, 11.24 %, 10.71 %, 10.26 % and 9.54 % in sugarcane trash mulch, wheat straw mulch, soybean straw mulch, interculturing operation and control (no mulch) methods, respectively. The values of per cent soil moisture increased over Control (no mulch) were 28.19 %, 17.81 %, 12.26 % and 7.54 % in sugarcane trash mulch, wheat

Table 6 : Percentage soil moisture increased over control (no mulch) and water use efficiency in various treatments

Treatments	Average soil moisture (%)	Percent soil moisture increased over control (no mulch)	Water use efficiency (kg/cm/ha)
M_1	12.23	28.19	37.37
M_2	11.24	17.81	36.67
M_3	10.71	12.26	36.39
M_4	10.26	7.54	35.35
M_5	9.54	----------	34.41

straw mulch, soybean straw mulch and intercultur operation, respectively.

Water use efficiency (WUE):

Water use efficiency was calculated by using the formula given in materials and methods and the values of water use efficiencies in sugarcane trash mulch, wheat straw mulch, soybean straw mulch, interculturing operation and Control (no mulch) were 37.37 kg/cm/ha, 36.67 kg/cm/ha, 36.39 kg/cm/ha, 35.35 kg/cm/ha and 34.41 kg/cm/ha, respectively. The Table 6 showed that the values of water use effocoemcu was better with is sugarcane trash mulch than other treatments because of soil moisture conservation.

Soil temperature:

Data regarding soil temperature studies are presented in Table 7 and depicted in Fig. 4. The soil temperature readings were taken with the help of soil thermometer, which were fixed at the soil surface, 15 cm depth and 30 cm depth in separate treatments. The value of the soil temperatures in sugarcane trash mulch were more as compared to other treatments at surface, 15 cm and 30 cm soil depths. The mean soil temperatures were 21.33^{0}c, 20.73^{0}C, 20.37^{0}C, 20.04^{0}C and 19.58^{0}C at sugarcane trash mulch, wheat straw mulch, soybean straw mulch, interculturing operation and control (no mulch)

Table 7 : Mean soil temperature (^{0}c) at different soil depths (cm) by various treatments throughout the crop growing period

Treatments	Soil temperature (^{0}C)			Mean
	Surface	15 cm	30 cm	
M_1	22.66	21.12	20.22	21.33
M_2	22.06	20.48	19.66	20.73
M_3	21.48	20.16	19.48	20.37
M_4	21.10	19.98	19.06	20.04
M_5	20.66	19.46	18.62	19.58

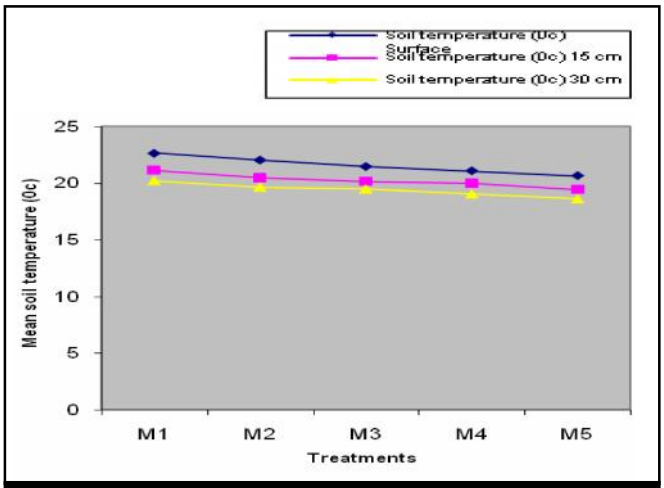

Fig. 4 : Mean soil temperature at different depths by various mulching treatments

treatments, respectively.

Sorghum grain yield:

The data regarding grain yield of sorghum by various treatments are presented in the Table 8m and graphically depicted in Fig. 5. The yield of grain sorghum was calculated for the experimental purpose. The total yields of the experimental plot in q/ha was calculated. The mean grain yield increased significantly with sugarcane trash mulch over other treatments *viz.*, wheat straw mulch, soybean straw mulch, interculturing operations and Control. The grain yield in sugarcane trash mulch, wheat straw mulch, soybean straw mulch, interculturing operations and Control were 28.04 q/ha, 27.15 q/ha, 26.75 q/ha, 25.82 q/ha and 24.89 q/ha, respectively.

Data presented in Table 8 showed that grain yield in sugarcane trash mulch was 28.00 q/ha to 28.08 q/ha, in wheat straw mulch the values was 27.16 q/ha to 27.17 q/ha, in soybean straw mulch the values of grain yield ranges from 26.75 q/ha to 26.78 q/ha, in Interculturing operation the values ranged from 25.86 q/ha to 25.97 q/ha and in Control (no mulch) treatment the values of grain yield of

Table 8 : Average yield of grain Sorghum (q/ha) at various treatments

Treatments	Replications				Mean
	1	2	3	4	
M_1	28.08	28.07	28.04	28.00	28.04
M_2	27.17	27.15	27.13	27.16	27.15
M_3	26.78	26.75	26.76	26.72	26.75
M_4	25.86	25.85	25.81	25.97	25.82
M_5	24.89	24.92	24.87	24.90	24.89
SE ±			0.00994		
C.D. (P=0.05)			0.0306		

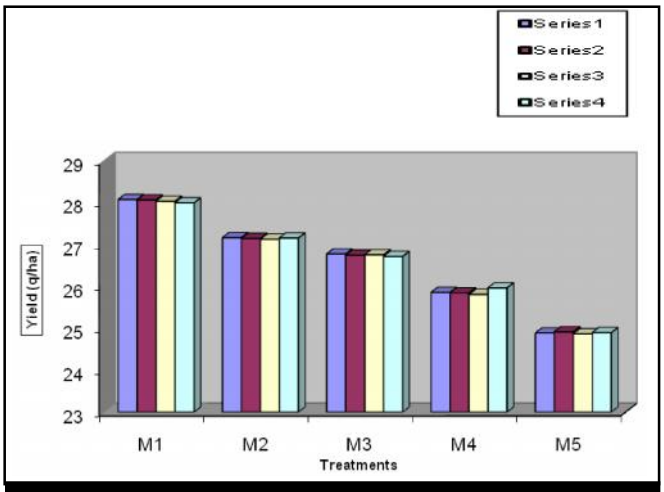

Fig. 5 : Average yield of *rabi* soughum (q/ha) at various mulching treatments

rabi sorghum was 24.89 q/ha to 24.90 q/ha at different replications.

Per cent increase in yield:

The per cent increase in *rabi* sorghum grain yield over control are presented in Table 9 and depicted in Fig. 6. Increase in yield over control (no mulch) were 12.64 %, 9.06 %, 7.46 % and 3.74 % in sugarcane trash mulch, wheat straw mulch, soybean straw mulch and interculturing operation, respectively.

Table 9 : Per cent increase in yield over control (no mulch) by various treatments

Treatments	Average yield (q/ha)	% Increased in yield over control (no mulch)
M_1	28.04	12.64
M_2	27.15	9.06
M_3	26.75	7.46
M_4	25.82	3.74
M_5	24.89	---------

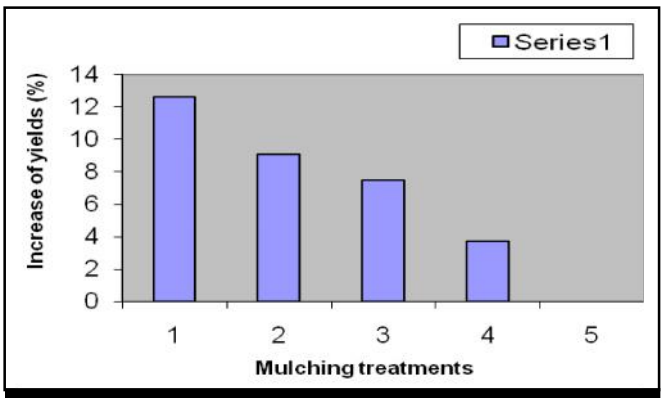

Fig. 6 : Per cent increase in grain yield over control (no mulch) treatment

Soil moisture use:

Soil moisture use increased with increase in initial moisture level. Similarly, sugarcane trash mulch, wheat straw mulch, soybean straw mulch utilized highest soil moisture compared to other treatments under study.

Water use efficiency:

Soil moisture water use efficiency (kg/cm/ha) was comparatively higher in sugarcane trash mulch, wheat straw mulch, soybean straw mulch and interculturing operation over control (no mulch). *i.e.* In sugarcane trash mulch (37.37), wheat straw mulch (36.67), soybean straw mulch (36.39), interculturing operation (35.67) and control (no mulch) was (34.41).

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