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PERFORMANCE OF DIFFERENT HYDROPHILIC SUBSTRATES ON SUNFLOWER PRODUCTION GROWN ON *ALFISOLS*

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ABSTRACT
An experiment was carried out at Zonal Agricultural Research Station, University of Agricultural Sciences, Gandhi Krishi Vigyan Kendra, Bengaluru during *kharif* seasons of 2014 and 2015 with an objective to evaluate the performance of hydrophilic substrates with respect to yield, yield parameters and moisture retention parameters in sunflower grown on *Alfisols.* The experiment consisted of 7 treatments laid out in randomized Complete Block design in three replications. Sunflower hybrid KBSH-53 was used and among the hydrophilic substrates hydrogel and humic acid were applied @2.5kg/ha, while vermi compost @ 2.5t/ha and fly ash @ 2.0t/ha. Irrigation was provided based on calculation of available soil moisture. The results emphasized that application of FYM, hydrogel, vermicompost or humic acid along with RDF for nutrient supply and as source of moisture conservation have resulted in higher values of, head diameter, oil content and 100 seed weight compared to sole application of 100% RDF. The two - year rainy season data also revealed that the seed yield and oil content of sunflower was influenced significantly by the combined effect of moisture conservation and nutrient source. Though magnitude of soil moisture variation was small, all the hydrophilic substrates maintained higher soil moisture compared to use of RDF only. The results of two - year experiments indicated that adoption of moisture conservation techniques through use of polymer hydrogel and application of organics like FYM or vermicompost are proved to be suitable from the point of both moisture retention as well as source of nutrients for nutrient exhaustive crop like sunflower.

KEY WORDS*:* Economics**,** Hydrophilic substrates, oil content, soil moisture, sunflower

INTRODUCTION

Sunflower gained importance and popularity as a commercial oilseed crop of India under rainfed conditions since its introduction during the seventies as an oilseed crop to India. This is due to its suitability to many agroecological regions, short duration, good quality oil and market price. This crop is mainly cultivated in rainy season and post rainy seasons of *alfisols* but can be grown in any season of the year since this crop is considered as day neutral plant because of its low photoperiod sensitivity. Karnataka is the leading sunflower producing state in the country and accounts for nearly 52% of the total area and 40% of the total production in the country. In India, sunflower is grown over an area of 5.20 lakh hectares with a production and productivity of 3.35 lakh tons and 643 kg per hectare, respectively during the year of 2015-16 (Anon, 2017). Though the crop has gained an important place among farmers, the productivity of sunflower is very low. The low productivity is mainly due to the crop growing under rainfed conditions on poor fertility soils with non-availability of cultivars under moisture and nutrient stress situations. This crop is often considered as a soil nutrient depleting crop, which puts heavy demands on soil and applied nutrients (Thavaprakash *et al.,* 2002). Due to its high uptake of nutrients sunflower responds very well to applied nutrients. Application of nutrients increased the seed yield of sunflower by 50% (Chorey and Thosar, 1997). The rainfed sunflower experiences erratic and undependable rainfall, excess and deficient of moisture within the same season. The critical analysis of production factors to increase the productivity of sunflower under different agro ecological situations of India revealed that moisture and nutrient are the key inputs to realize higher and sustainable production of sunflower cultivars under rainfed conditions. The rainfed farmers are resource poor and identification of best agronomic practices suited to moisture and nutrient stress conditions are vital. Hydrophilic polymers like hydrogel have capability to store extra water in soil that enables crop to utilize the water over an extended period of time. Application of humic acid, fly ash and organic matter either through farmyard manure or vermicompost have been shown to increase CEC and improve soil texture and porosity leading to retention of higher soil moisture in the soil. FYM/ vermicompost in addition to moisture retention they act as nutrient sources also. Keeping these facts in view, present study was carried out to evaluate the performance of hydrophilic substrates with respect to yield, yield attributes and moisture retention parameters in sunflower grown on *alfisols*.

MATERIALS & METHODS

The field experiment was conducted during the *kharif* seasons of 2014 and 2015 at Zonal Agricultural Research Station (ZARS), University of Agricultural Sciences, Bengaluru, Karnataka, India. Geographically the

experiment place is located in Eastern Dry Zone (Zone -5) of Karnataka State, which falls between 13.00' N latitude and 77.35'E longitude with an altitude of 925 meters above mean sea level. The soil of the experimental site belongs to red loam texture. The soil of the experimental field in both years was sandy to sandy loam with pH of 6.40 to 6.70, organic carbon from 0.51to 0.57 %, available phosphorus 65 kg/ha and available potassium 105 kg/ha. The soil has field capacity of 18 to 22% and permanent wilting point of 8.47% to 10.2%. The potential sunflower hybrid ,KBSH -53 was used with seven treatments viz., T1: RDF, T2: RDF + 5t FYM/ha spreading across field, T3: RDF + 2.5t FYM/ha in seed furrows, T4: RDF + Hydrogel @ 2.5kg/ha in seed furrows, T5: RDF + Humic acid @ 2.5 kg/ha in seed furrows, T6: RDF + Vermicompost @ 2.5t/ha in seed furrows and T7: RDF + Fly ash @ 2t/ha in seed furrows. These hydrophilic substrates are applied to seed furrows by mixing with soil. Irrigation was provided based on calculation of available soil moisture which was monitored at regular intervals. The experiment was laid out in randomized complete block design with three replications. The observations were recorded on growth, yield attributes and yield. Costs and returns were computed based on the prevailing market price. The oil content of sunflower seed was estimated by using Nuclear Magnetic Resonance (NMR) method. The results were analyzed with suitable statistical procedures / methods.

RESULTS & DISCUSSION

Rainfall and number of rainy days during the growth period

Rainfall between August and November, the most effective rainfall period for sunflower growth varied from 703.8 in 2014; to 586.8 in 2015 against the past 15 years average of 922mm which were received in 34 and 35 rainy days, respectively. However, entire year recorded 994.5mm in 56 days during 2014 and 1070.5mm in 71 days during 2015 (Table 1). The quantum and distribution of rainfall was found to be little erratic as compared to normal trend.

TABLE 1. Rainfall (mm) and number of rainy days observed during sunflower growth period

Month	2014		2015	
	Rainfall (mm)	No.of rainy days	Rainfall (mm)	No.of rainy days
August	117.4	7	71.0	8.0
September	128.6	10	254.6	9.0
October	428.4	15	80.8	5.0
November	29.4	2	180.4	13.0
Total	703.8	34	586.8	35
Total (Entire Year)	994.5	56.0	1070.5	71

Yield and yield attributes

The datarevealed that during rainy seasons of 2014 and 2015 application of RDF + 2.5t FYM/ha in seed furrows(T3) resulted in highest head diameter (15.60cm and 16.10cm, respectively) followed by T4:RDF + Hydrogel @ 2.5kg/ha in seed furrows (15.10cm and 15.80cm, respectively), T6:RDF + Vermicompost @ 2.5t/ha in seed furrows (15.00cm and 15.70cm, respectively) and T5:RDF + Humic acid @ 2.5 kg/ha in seed furrows (14.90cm and 15.50cm, respectively) as compared to application of only RDF (T1) (14.6cm and 15.0cm, respectively). Similar trend was also observed with 100 seed weight and oil content (Table 2).

TABLE 2. Effect of hydrophilic substrates on the performance of yield and yield parameters of sunflower

Treatments	Head Diameter (cm)		100 seed weight (g)		Oil Content (%)		Seed Yield (kg / ha)	
	2014	2015	2014	2015	2014	2015	2014	2015
T_1: RDF	14.60	15.00	4.70	4.25	30.01	30.94	1950	1892
T_2: RDF + 5t FYM/ha spreading across field	15.30	15.80	5.02	4.72	38.98	36.20	2172	2303
T_3:RDF + 2.5t FYM/ha in seed furrows	15.60	16.10	5.13	4.79	38.99	37.89	2270	2306
T_4:RDF + Hydrogel @ 2.5kg/ha in seed furrows	15.10	15.80	5.02	4.58	36.03	35.78	2114	2202
T_5:RDF + Humic acid @ 2.5 kg/ha in seed furrows	14.90	15.50	4.81	4.55	34.30	32.04	2013	2158
T_6:RDF + Vermicompost @ 2.5t/ha in seed furrows	15.00	15.70	4.89	4.56	34.38	32.82	2096	2181
T_7: RDF + Fly ash @ 2.t/ha in seed furrows	14.80	15.20	4.80	4.48	34.25	31.28	2003	2087
SEm±	0.379	0.379	0.118	0.171	0.208	0.218	78.92	94.56
CD(P=0.05)	NS	NS	NS	NS	0.641	0.636	NS	NS

The results emphasize that application of FYM, hydrogel, vermicompost or humic acid along with RDF for nutrient supply and as source of moisture conservation have resulted in higher values of, head diameter, oil content and 100 seed weight compared to sole application of 100% RDF(T1). The moisture conservation effect and rainfall observed during the crop growth indicates that due to the use of hydrophilic substrates the effect of deficit in rainfall during 2014 is reduced on the growth performance of the crop. The benefits of soil moisture conservation and nutrient supply in sunflower is also reported by Reddy *et al.,* 2003, Bakery *et al.,* 2009 and Aravinda Kumar *et al.,* 2010.

The two - year rainy season data (Table 2) also revealedthat the seed yield and oil content of sunflower was influencedsignificantly by the combined effect of

moisture conservation and nutrientsource. During 2014, although seed yield of sunflower was non-significant , the highest seed yield was observed with T3: RDF + 2.5t FYM/ha in seed furrows (2270kg/ha) followed by followed by T4: RDF + Hydrogel @ 2.5kg/ha in seed furrows (2114kg/ha), T6: RDF + Vermicompost @ 2.5t/ha in seed furrows (2096kg/ha) and T5: RDF + Humic acid @ 2.5 kg/ha in seed furrows (2013 kg/ha) as compared to lowest yield recorded with T1: RDF (1950 kg/ha) which was 14.09% lesser than the highest yield recorded with T3. However, during 2015 seed yield of sunflower was significantly influenced by the combined effect of moisture conservation and nutrient source. Significantly higher seed yield (2306 kg /ha) was observed with T3: RDF + 2.5t FYM/ha in seed furrows and it was on par with T4: RDF + Hydrogel @ 2.5kg/ha in seed furrows (2202kg/ha), T6: RDF + Vermicompost @ 2.5t/ha in seed furrows (2181kg/ha), T5: RDF + Humic acid @ 2.5 kg/ha in seed furrows (2158 kg/ha)andT7: RDF + Fly ash @ 2t/ha in seed furrows (2087kg/ha). But significantly lower seed yield was observed with application of only RDF (1892 kg /ha) which was 17.95% lesser than highest seed yield obtained with T3.

Oil content differed significantly in both the years of experimentation. Significantly higher oil content was observed with T3: RDF + 2.5t FYM/ha in seed furrows (38.99% in 2014 and 37.89% in 2015) followed by T4: RDF + Hydrogel @ 2.5kg/ha in seed furrows (36.03% in 2014 and 35.78 % in 2015)and T6: RDF + Vermicompost @ 2.5t/ha in seed furrows (34.38% in 2014 and 32.82% in 2015). Significantly lowest oil content was observed with sole application of RDF i.e T1 (30.01% in 2014 and 30.94% in 2015) which was 23.04% and 18.45% lower than what is recorded in best treatment i.e T3. The oil content during 2014 was higher than during 2015. This might be due to rainfall occurred during flowering in 2015 which has caused pollen wash thereby reducing the oil content. Irrespective of the treatments, the seed yields recorded during 2014 are lower as compared to 2015. Between the years, the quantity of sunflower yield reduction in 100% RDF was higher by 17.95% in 2015 than in 2014 (14.09%) when compared to T3: RDF + 2.5t FYM/ha in seed furrows (2270kg/ha in 2014 and 2306 kg/ha in 2015). This is mainly due to the moisture conservation in FYM, hydrogel and vermicompost applied plots. Data in table 4 reveals that mean soil moisture after 30,45 and 60 days after sowing and also at harvest was found to be highest with T3: RDF + 2.5t FYM/ha in seed furrows (13.57% to 9.87% in 2014 and 12.75% to 8.78% in 2015), T4: RDF + Hydrogel @ 2.5kg/ha in seed furrows (11.59% to 8.14% in 2014 and 12.24% to 8.36% in 2015) and T6: RDF + Vermicompost @ 2.5t/ha in seed furrows(11.41% to 8.16% in 2014 and 12.04 % to 8.24% in 2015) as compared to RDF alone application (T1: 9.95% to 6.14% in 2014 and 10.37% to 6.64% in 2015). Though magnitude of soil moisture variation was small, all the hydrophilic substrates maintained higher soil moisture compared to use of RDF only. This indicates that FYM and vermicompost applied plots have resulted in both moisture conservation and nutrient supply whereas, hydrogel has resulted in moisture conservation and the sunflower crop has made utilization of both moisture as well as nutrient very well during its growth and development.Similarresults have been observed by Megur*et al.,* 1993, Devidayal andAgarwal 1998. There is strong interaction between nutrient source and moisture availability for crop yield. Application of nutrients facilitates root growth, which can extract soil moisture from deeper layers and moisture conservation practices ensured the better availability of moisture to the plants. Furthermore, supply of nutrients facilitates early development of canopy that covers the soil and intercepts more solar radiation and thereby reduces the evaporation component of the evapo-transpiration.

TABLE 3. Effect of hydrophilic substrates on economic parameters of sunflower production

Treatments	Gross returns (Rs./ha)		Cost of cultivation (Rs./ha)		Net returns (Rs./ha)		B:C ratio	
	2014	2015	2014	2015	2014	2015	2014	2015
T_1: RDF	58513	71902	25194	27521	33319	44381	2.32	2.61
T_2: RDF + 5t FYM/ha spreading across field	65153	87524	25194	27196	39959	60328	2.59	3.22
T_3:RDF + 2.5t FYM/ha in seed furrows	68104	87617	27694	32196	40410	55421	2.46	2.72
T_4:RDF + Hydrogel @ 2.5kg/ha in seed furrows	63422	83670	35194	39696	28228	43974	1.80	2.10
T_5:RDF + Humic acid @ 2.5 kg/ha in seed furrows	60386	82017	30194	31696	30192	50321	2.00	2.59
T_6:RDF + Vermicompost @ 2.5t/ha in seed furrows	62883	82887	29694	47196	33189	35691	2.12	1.76
T_7: RDF + Fly ash @ 2.t/ha in seed furrows	60102	79300	25519	27196	34583	52104	2.36	2.92
SEm±	2368	35912	-	-	2368	3592	0.082	0.127
CD(P=0.05)	NS	NS	-	-	7297	11068	0.253	0.391

Economic analysis

The individual two years data pertaining tothe gross returns, cost of cultivation, net returns and B C ratioare given in Table 3.Maximum gross return was observed with T2: RDF + 5t FYM/ha spreading across field (Rs.68104 in 2014 and Rs.87617 in 2015)whereas, lowest gross return was recorded with T1: RDF (Rs.58513 in 2014 and 71902 in 2015).Maximum net returns was recorded with T2: RDF + 5t FYM/ha spreading across field (Rs.39239 in 2014 and Rs.60328 in 2015) and T3: RDF + 2.5t FYM/ha in seed furrows(Rs.40410 in 2014 and Rs.54998 in 2015) compared to rest of the treatments. Similarly highest B:C ratio was recorded with FYM spreading across the field (2.51 in 2014 and 3.22 in 2015) and FYM in seed rows (2.45 in 2014 and 2.68 in 2015).Similar results were observed by Kazen*et al.,* (2013) and Singh *et al.,* (2005). The higher gross returns, net returns and B:C ratio of moisture conservation and nutrient sources might be due to higher seed yield coupled with higher market price during both the years.

TABLE 4. Mean soil moisture (%) at different growth stages as influenced by hydrophilic substrates in sunflower

Treatments	Mean Soil Moisture (%) after sowing							
	30 DAS		45 DAS		60 DAS		At Harvest	
	2014	2015	2014	2015	2014	2015	2014	2015
T_1: RDF	9.95	10.37	11.29	12.12	7.96	8.38	6.14	6.64
T_2: RDF + 5t FYM/ha spreading across field	12.62	12.86	13.93	13.86	10.17	9.94	9.17	8.24
T_3:RDF + 2.5t FYM/ha in seed furrows	13.57	12.75	14.52	14.39	10.49	10.12	9.87	8.78
T_4:RDF + Hydrogel @ 2.5 kg/ha in seed furrows	11.59	12.24	13.15	13.44	9.89	9.81	8.14	8.36
T_5:RDF + Humic acid @ 2.5 kg/ha in seed furrows	10.85	11.93	12.02	13.25	8.63	9.50	8.11	7.94
T_6:RDF + Vermicompost @ 2.5t/ha in seed furrows	11.41	12.04	12.54	13.29	9.56	9.71	8.16	8.24
T_7: RDF + Fly ash @ 2.t/ha in seed furrows	10.69	10.51	11.59	12.30	9.25	9.23	7.10	7.31
SEm±	0.387	0.402	0.692	0.629	0.201	0.126	0.497	0.379
CD(P=0.05)	1.130	1.238	NS	NS	0.502	0.388	1.451	1.168

DAS – Days after sowing

The results of two-year experiment indicated that adoption of moisture conservation techniques through use of polymer hydrogel and application of organics like FYM or vermicompost are proved to be suitable from the point of both moisture retention as well as source of nutrients for nutrient exhaustive crop like sunflower. The higher quantities of soil moisture retained by the hydrophilic substrates provide extra available water to crops which facilitates better crop growth. More available water in the soil also means less frequent irrigation. Use of hydrophilic substrates helps in reducing the crop water requirements marginally and thus will address the adversities of climate change.

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