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# Impact of organic manures and hydrophilic polymer hydrogel on conservation of moisture and sunflower production under rainfed condition

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**A**BSTRACT : The experiment was conducted at Oilseeds Research Unit Dr. P. D. K. V, Akola, during 2015-16 using a Randomized Block Design with three replications along with seven treatments *viz.*, RDF (80:60:30), RDF + 5t FYM/ha spreading across field, RDF + 2.5t FYM/ha in seed furrows, RDF + hydrogel @ 2.5kg/ha in seed furrows, RDF + humic acid @ 2.5 kg/ha in seed furrows, RDF + vermicompost @ 2.5t/ha in seed furrows and RDF + Fly ash @ 2.5 t/ha in seed furrows. This study was carried out with specific objectives of higher moisture retention and slow release to tide over intermittent drought in *Kharif*. The result showed that growth parameters *viz.*, plant height, head diameter and 100 seed weight varied significantly due to use of moisture retentive material on sunflower. Application of 100 per cent RDF with vermicompost @ 2.5t/ha recorded highest seed yield which was at par with the application of 100 per cent RDF with hydrogel. Remaining treatments were at par with each other. Among the treatments, highest moisture was observed with application of 100 per cent RDF with vermicompost @ 2.5t/ha at 30 DAS. After 45 DAS, 60 DAS and at harvest application of 100 per cent RDF with hydrogel @2.5 kg/ha in seed furrows recorded highest moisture percentage at different growth stages followed by vermicompost.

**K**EY **W**ORDS : Sunflower, Organic manure, Yield

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Sunflower is an important oilseed crop cultivated for its premier oil and manifold uses both of industrial and pharmaceutical. Sunflower hold promise because of its short duration, thermo and photo insensitivity, drought tolerance, suitable in existing crop rotation, high oil content, and having characteristics like wide adaptability with low diseases and insect incidence. The productivity of sunflower in India is low (791 kg/ha) as compared to other nations and one of the reason for low productivity is due to its cultivation mainly under rainfed conditions with sub optimal crop stand, imbalanced nutrition and lack of soil moisture conservation techniques, thus leading to poor seed set and high per cent of chaffy seed, low oil content and yield.

The rainfed sunflower experiences erratic and undependable rainfall, moisture excess and deficit, within the same season. The farmers of the investigated region are resource poor and use very little fertilizer. Identification of cultivars suited to moisture and stress conditions is vital for the farmers of this region. Hence, performance of three sunflower cultivars was evaluated to identify most suitable cultivar for moisture and nutrient stress situations (Reddy *et al.*, 2005).

Sunflower is resistant to drought but requires continuous availability of soil moisture for optimal performance. Water is an important life saving natural resource for the crop. It profoundly influences photosynthesis, respiration, absorption, translocation and utilization of mineral nutrients and cell division. Due to limited availability of irrigation water in India, it is important to increase irrigation efficiency and water productivity of crop and to exploit the existing water potential by reducing the losses of water and also ensuring better living condition for crop growth. The use of organic manures and soil conditioners like super absorbent polymer has a great potential to exploit the existing water in soil for agricultural crop by increasing their production. Actually, the polymer has capability to store extra water in soil that enables crops to utilize the water over an extended period of time.

Water is an important life saving natural resource for the crop. It profoundly influences photosynthesis, respiration, absorption, translocation and utilization of mineral nutrients and cell division. Due to limited availability of irrigation water in India, it is important to increase irrigation efficiency and water productivity of crop and to exploit the existing water potential by reducing the losses of water and also ensuring better living condition for crop growth. The use of soil conditioners like super absorbent polymer (hydrogel) has a great potential to exploit the existing water in soil for agricultural crops by increasing their production. Actually, the polymer has capability to store extra water in soil that enables crops to utilize the water over an extended period of time.

Hydrogel (Super absorbent polymer) is a water retaining, cross-linked hydrophilic, biodegradable amorphous polymer which can absorb and retain water at least 400-1500 times of its original weight and make at least 95 per cent of stored water available for crop absorption (Johnson and Veltkamp, 1985). When polymer is mixed with the soil, it forms an amorphous gelatinous mass on hydration and is capable of absorption and desorption over long period of time, hence, acts as a slow release source of water in soil. The hydrogel particles may be taken as "miniature water reservoir" in the soil and water will be removed from these reservoirs upon the root demand through osmotic pressure difference. Johnson (1984) reported that use of hydrogel increase the amount of available moisture in root zone, thus, implying longer intervals between irrigations. The effect of hydrogel is affected if they are allowed to dry out and thus irrigation is important for longevity of hydrogel. Hydrogel can be applied by either mixing with the soil or by spraying. While using the spray technique, hydrogels can be mixed with micronutrients and pesticides.

Humic acid enhances the soil moisture content. It increases seed germination rate as well as seed respiration. It also enhances leaf and root respiration and chlorophyll content of the leaves. It promotes the synthesis of phenolic compounds such as anthocyanins and flavonoids which may improve the plant quality and act as a deterrent to pests and diseases.

Vermicomposting is a simple process in which certain species of earthworms are used to enhance the process of waste conversion and produce a better end product. It is a mesophilic process utilizing micro-organisms and earthworms active at 10-12$^0$C. The material passes through earthworm gut whereby it converted to earthworm casting which are rich in microbial activity, plant growth regulators and fortified with pest repellence attributes as well. In short earthworms through type of biological alchemy are capable of transforming garbage into gold (Vermi Co. 2001 and Tara crescent 2003). It retains more water than other manures.

Fly ash is end residue of pulverized bituminous coal (lignite) in the furnace of thermal plants and consists of mineral constituents of coal which is not full burnt. Fly ash has great potentiality in agriculture due to its efficacy in modification of soil health and crop performance. Pandey *et al*. (1994) reported that sunflower plants treated with fly ash exhibited improved growth.

FYM is the decomposed mixture of dung and urine of farm animals along with litter and left over material from roughages or fodder fed to cattle. FYM contains 0.5 per cent N, 0.2 per cent $P_2O_5$ and 0.5 per cent $K_2O$. Bacteria and actinomycetes play active role in decomposition. It contains 60-70 per cent moisture in initial stage and 30-40 per cent moisture in the decomposed manure. FYM is the most commonly used organic manure in India.

This requires a comparative study on relative performance of organic manure and hydrophilic polymer hydrogel on sunflower production under rainfed condition.

## RESEARCH PROCEDURE

A field experiment was conducted at Oilseeds Research unit, Dr. P. D. K. V, Akola, during *Kharif* 2015-16. The trial was laid out in Randomized Block Design with three replications along with seven treatments *viz.*, RDF (80:60:30), RDF + 5t FYM/ha spreading across field, RDF + 2.5t FYM/ha in seed furrows, RDF + hydrogel @ 2.5kg/ha in seed furrows, RDF + humic acid @ 2.5 kg/ha in seed furrows, RDF + vermicompost @ 2.5t/ha in seed furrows and RDF + fly ash @ 2.5 t/ha in seed furrows. The crop was sown on 28th July 2015. This study was carried out with specific objectives of higher moisture retention and slow release to tide over intermittent drought in *Kharif* and minimising irrigation requirement for *Rabi* crops. The rainfall received during cropping period was 484.4 mm with 15 rainy days. These amounts were considered to be less than normal rainfall. Observations were recorded for growth dynamics, yield components and total yield. Economics were computed based on the prevailing market price. The oil content of sunflower seed was estimated using the nuclear magnetic resonance (NMR) method (Model Oxford mQA 6005).

## RESEARCH ANALYSIS AND REASONING

The findings of the present study as well as relevant discussion have been presented under following heads :

**Effect on conservation of moisture :**

The results showed wide variation in moisture percentage during different growing stage of sunflower. Data regarding Table 1 revealed that highest moisture (25.68%) was observed with application of 100% RDF with vermicompost@ 2.5t/ha at 30 DAS. After 45 DAS (28.24%), 60 DAS (22.47%) and at harvest (17.74%), application of 100% RDF with hydrogel @2.5 kg/ha in seed furrows recorded highest moisture percentage at

**Table 1: Moisture per cent of sunflower as influenced by different organic manures (0-30 cm depth)**

| Treatments | 30 DAS | 45 DAS | 60 DAS | At harvest |
|---|---|---|---|---|
| $T_1$: RDF (80:60:30) | 18.66 | 20.30 | 16.32 | 14.75 |
| $T_2$: RDF + 5t FYM/ha spreading across field | 18.97 | 21.21 | 16.66 | 14.64 |
| $T_3$: RDF + 2.5t FYM/ha in seed furrows | 19.21 | 20.30 | 16.98 | 15.00 |
| $T_4$: RDF + Hydrogel @ 2.5kg/ha in seed furrows | 21.48 | 28.24 | 22.47 | 17.74 |
| $T_5$: RDF + Humic acid @ 2.5 kg/ha in seed furrows | 19.66 | 26.32 | 17.89 | 15.49 |
| $T_6$: RDF + Vermicompost @ 2.5t/ha in seed furrows. | 25.68 | 27.37 | 20.51 | 15.62 |
| $T_7$: RDF + Fly ash @ 2.5 t/ha in seed furrows | 21.02 | 26.53 | 19.44 | 15.22 |

**Table 2 : Growth and yield attributes of sunflower as influenced by different organic manures**

| Treatments | Plant height (cm) | Head diameter (cm) | 100 seed weight (g) | Oil content (%) | Oil yield kg/ha |
|---|---|---|---|---|---|
| $T_1$ : RDF | 104.5 | 8.3 | 3.67 | 31.1 | 302 |
| $T_2$ :RDF + 5t FYM/ha spreading across field | 106.9 | 9.1 | 4.00 | 30.9 | 335 |
| $T_3$ : RDF + 2.5t FYM/ha in seed furrows | 107.7 | 9.7 | 4.17 | 31.0 | 354 |
| $T_4$ :RDF + Hydrogel @ 2.5kg/ha in seed furrows | 118.9 | 16.1 | 4.33 | 30.7 | 381 |
| $T_5$ :RDF + Humic acid @ 2.5 kg/ha in seed furrows | 110.2 | 10.7 | 4.17 | 31.0 | 367 |
| $T_6$: RDF + Vermicompost @ 2.5t/ha in seed furrows. | 124.2 | 17.7 | 4.83 | 30.8 | 395 |
| $T_7$: RDF + Fly ash @ 2.5 t/ha in seed furrows | 112.1 | 12.1 | 4.23 | 30.9 | 372 |
| S.E.± | 3.98 | 1.15 | 0.19 | 0.33 | 17.96 |
| C.D. (P=0.05) | 12.28 | 3.55 | 0.59 | NS | 55.36 |
| CV % | 6.16 | 16.75 | 7.95 | 1.87 | 8.69 |

NS=Non-significant

different growth stages followed by vermicompost. The similar result was finding with Hayat and Ali (2004).

Use of hydrogel increased the amount of available moisture in the root zone resulting in longer intervals between irrigations (Abedi-Koupai and Sohrab, 2004; Allahdadi *et al.*, 2005; El-Hady *et al*., 1981 and Flannery and Busscher, 1982).

Hayat and Ali (2004) conducted field experiment to study the effect of synthetic polymer on water absorption and soil properties in tomato and reported that moisture content in the polymer treated soil increased from 30-85 per cent.

**Effect on growth and yield :**

Data regarding Table 2 reported that growth and yield parameters *viz.*, plant height, head diameter and 100 seed weight varied significantly due to use of moisture retentive materials on sunflower. The plant height (124.2 cm), head diameter (17.7 cm) and 100 seed weight (4.83 g) was significantly highest in application of 100 per cent RDF with vermicompost @ 2.5t/ha followed by hydrogel @ 2.5 kg/ha.

Application of 100 per cent RDF with vermicompost @ 2.5t/ha recorded highest seed yield (1281 kg/ha) and oil yield (395 kg/ha) which was at par with the application of 100% RDF with hydrogel (1241 kg/ha and 381 kg/ha). Remaining treatments were at par with each other. There is no any significant effect on oil content of sunflower.

An increase in growth and yield related attributes in the present investigation could be because of sufficient availability of water and indirectly nutrients supplied by the super absorbent polymer to the plant under water stress condition, which in turn lead to better translocation of water, nutrients and photoassimilates and finally better plant development. Similar results of incorporating superabsorbent polymer into the soil on yield have been reported by Sivapalan (2006) in soybean and El-Hady *et al.* (1981) in cucumber under water stress condition.

**Economics:**

As regards Table 3, highest gross (Rs. 42266/ha), net monetary returns (Rs. 24475/ha) and also B: C ratio (2.38) was recorded in RDF + vermicompost @ 2.5t/ha in seed furrows followed by application of 100% RDF with hydrogel. The lowest gross return (Rs. 32039/ha) was recorded under recommended dose of fertilizer (80:60:30 kg NPK/ha). The higher gross returns, net returns and B:C of the recommended fertilizer dose with application of vermicompost might be due to higher seed

**Table 3: Yield and economics of sunflower as influenced by different organic manures**

| Treatments | Seed yield (kg/ha) | GMR (Rs.ha$^{-1}$) | NMR (Rs.ha$^{-1}$) | B: C |
|---|---|---|---|---|
| $T_1$: RDF (80:60:30) | 971 | 32039 | 15998 | 2.00 |
| $T_2$: RDF + 5t FYM/ha spreading across field | 1082 | 35719 | 18178 | 2.04 |
| $T_3$: RDF + 2.5t FYM/ha in seed furrows | 1141 | 37652 | 20861 | 2.24 |
| $T_4$: RDF + Hydrogel @ 2.5kg/ha in seed furrows | 1241 | 40957 | 23716 | 2.38 |
| $T_5$: RDF + Humic acid @ 2.5 kg/ha in seed furrows | 1181 | 38961 | 22680 | 2.39 |
| $T_6$: RDF + Vermicompost @ 2.5t/ha in seed furrows | 1281 | 42266 | 24475 | 2.38 |
| $T_7$: RDF + Fly ash @ 2.5 t/ha in seed furrows | 1205 | 39772 | 22731 | 2.33 |
| S.E.± | 56.97 | 1880 | - | - |
| C.D. (P=0.05) | 175.55 | 5793 | - | - |
| CV % | 8.53 | 8.53 | - | - |

**Table 4 : Correlation co-efficient between growth parameters and seed yield**

| | Plant height (cm) | Head diameter (cm) | 100 seed weight (g) | Volume weight | Seed yield (kg/ha) |
|---|---|---|---|---|---|
| Plant height (cm) | 1.000 | | | | |
| Head diameter (cm) | 0.994** | 1.000 | | | |
| 100 seed weight (g) | 0.925** | 0.890** | 1.000 | | |
| Volume weight | -0.137 | -0.109 | -0.048 | 1.000 | |
| Seed yield (kg/ha) | 0.877** | 0.864* | 0.925** | 0.141 | 1.000 |

* and ** indicate significance of values at P=0.05 and 0.01, respectively

yield coupled with higher market price.

Vadiraj *et al*. (1998) revealed that application of vermicompost in coriander (*Coriandrum sativum* L.) significantly increased herbage and seed yield as compared to chemical fertilizers. The herbage yield was maximum in Rcr-41 (6067.5 kg $ha^{-1}$) at $60^{th}$ day after sowing when 15t $ha^{-1}$ of vermicompost was applied and seed yield was maximum in Rcr-41 (1314 kg $ha^{-1}$) in plants treated with 20 t $ha^{-1}$ vermicompost.

**Linear correlation among growth and yield parameters :**

As regards Table 4, the growth parameters had positive correlations with the yield parameters indicating that a good growth affected by organic manures *viz.*, FYM, hydrogel, humic acid and vermicompost. But there was negative correlation between yield and volume weight. Seed yield had highly significant positive correlated with plant height at harvest, head diameter, 100 seed weight but negatively correlated with volume weight.

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