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Original Research Article

Efficacy of Hydrophilic Polymer Hydrogel and Water Retentive Material on Growth and Yield of Sunflower

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Keywords

Sunflower, Hydrogel, Organic manures, Yield and soil moisture percent

A B S T R A C T

The experiment was conducted at Oilseeds Research Unit, Dr. P. D. K. V., Akola, during 2014-15 to 2016-17 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. Three years data and pooled results indicated that application of 100 % RDF + Vermicompost @ 2.5 t ha^{-1} (T_6) found to be superior in recording significantly higher growth parameters, seed and oil yield of sunflower, but it was closely followed by application of 100 % RDF + hydrogel @ 2.5 kg ha^{-1}. Higher moisture % in soil up to 30 cm depth was maintained with the application of 100 % RDF + hydrogel @ 2.5 kg ha^{-1} during maximum growth stages of sunflower.

Introduction

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 rotations, high oil content, and having characteristics like wide adaptability with low disease and insect incidences. The productivity of sunflower in India is low (791 kg/ha) as compared to other nations and some of the reasons for low productivity are 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 percent of chaffy seed, low oil content and yield.

The rainfed *Kharif*-sunflower experiences erratic and undependable rainfall, moisture excess and deficit, within the same season. Sunflower is resistant to drought but requires continuous availability of soil moisture for optimal performance. Water is an important lifesaving natural resource for

the crop. It profoundly influences photosynthesis, respiration, absorption, translocation and utilization of mineral nutrients and cell division. 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.

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. 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.

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. Pande *et al.*, (2010) reported that Sunflower plants treated with fly ash exhibited improved growth.

Vermicomposting is being used increasingly as plant growth media and soil amendments. In vermicompost, accelerated bioxidation of organic matter is achieved mostly by high-density earthworm populations (Dominguez *et al*., 1997; Subler *et al.,* 1998). It produces peat like material with high porosity, aeration, drainage water holding capacity and microbial activity which is stabilized by interactions between earthworm and micro-organisms in a non thermophilic process (Edwards and Burrows, 1988). Nutrients present in vermicompost are readily available for plant uptake (Orozco *et al.*, 1996).

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% N, 0.2% P_2O_5 and 0.5% K_2O. Bacteria and actinomycetes play active role in decomposition. It contains 60-70% moisture in initial stage and 30-40% 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.

Materials and Methods

A field experiment was conducted at Oilseeds Research Unit, Dr. P. D. K. V, Akola, during *kharif* 2014-15 to 2016-17. The trial was laid out in randomized block design with three replications along with seven treatment viz., RDF (80:60:30), RDF + 5t FYM ha^{-1} spreading across field, RDF + 2.5t FYM ha^{-1} in seed furrows, RDF + Hydrogel @ 2.5kg ha^{-1} in seed furrows, RDF + Humic acid @ 2.5 kg ha^{-1} in seed furrows, RDF + Vermicompost @ 2.5t ha^{-1} in seed furrows and RDF + Fly ash @ 2.5 t ha^{-1} 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 and minimising irrigation requirement for rabi crops. The rainfall received during cropping period was 593.1, 645.0 and 832.3 mm with

32, 28 and 45 rainy days during *Kharif* 2014-15, 2015-16 and 2016-17, respectively. Observations were recorded for growth dynamics, yield components and total yield. The oil content of sunflower seed was estimated using the nuclear magnetic resonance (NMR) method (Model Oxford mQA 6005).

Results and Discussion

Effect on growth seed and oil yield

Pooled data presented in Table 1 and graphically presented in figure 1, indicated that application of 100% RDF with Vermicompost @ 2.5 t ha^{-1} recorded significantly highest plant height (138.27 cm), head diameter (16.31 cm) and 100 seed weight (4.9 g) but found statistically at par with the application of 100% RDF with hydrogel @ 2.5 kg ha^{-1}. Whereas lowest values were recorded with the application of 100 % RDF (80:60:30 kg NPK kg ha^{-1}) alone. In case of oil content, application of 100 % RDF + humic acid @ 2.5 kg ha^{-1} (T_5) found significantly superior. This might be due to better crop growth, facilitated by the improvement in soil physical, chemical and biological properties as well as plant nutrition with the addition of organic manure and availability of soil moisture due to addition of water retentive material. Similar findings have also been reported Rasool *et al.,* (2013) and Gaikwad Godavari *et al.*, (2017).

Effect on seed and oil yield

Data compiled on sunflower seed and oil yield (kg ha^{-1}), revealed that during 2014-15, significantly highest seed yield (713 kg ha^{-1}) was obtained with the application of 100% RDF (80:60:30 kg NPK kg ha^{-1}) alone which was strongly followed by treatment of application of 100% RDF with Vermicompost @ 2.5 t ha^{-1} and 100 % RDF + Hydrogel @ 2.5 kg ha^{-1}. Whereas, during 2nd and 3rd year of study and pooled over season, significantly highest seed yield was acquired with the application of 100% RDF with Vermicompost @ 2.5 t ha^{-1} as compare to other treatments, but it was not found statistically superior to application of 100 % RDF + Hydrogel @ 2.5 kg ha^{-1} (T_4) and application of 100 % RDF + humic acid @ 2.5 kg ha^{-1} (T_5). The lowest seed yield was recorded with 100 % RDF alone. As oil yield is openly related with seed yield, the same trend was observed in oil yield kg ha^{-1}.

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 or water retentive material to the plant under water stress condition, which in turn lead to better translocation of water, nutrients and photo assimilates and finally better plant development. Similar results of incorporating superabsorbent polymer into the soil on yield have been reported by Sivapalan (2006) in soybean. Manjunatha *et al.,* (2009) reported same results when FYM was incorporated and Vedpathak and Chavan (2016) when vermicopost was incorporated in the soil (Fig. 2 and Table 2).

Effect on conservation of soil moisture

The pooled data pertaining to moisture % in soil up to 30 cm depth presented in table 3, pointed that at 30 DAS application of 100% RDF + Vermicompost @ 2.5 t ha^{-1} recorded significantly highest soil moisture % than all other treatments. Whereas at 45 DAS, 60 DAS and at harvest, application of 100 % RDF + Hydrogel @ 2.5 kg ha^{-1} maintained significantly highest moisture % in soil than all other treatments under study, except treatment T_6 i.e., application of 100% RDF + Vermicompost @ 2.5 t ha^{-1} (Fig. 3).

Table.1 Growth and yield attributes of sunflower as influenced by different treatments (Pooled 2014-2017)

Treat	Plant height (cm)	Head diameter (cm)	100 seed weight (gm)	Oil content (%)
T_1: RDF (80:60:30)	118.40	10.89	3.84	35.92
T_2: RDF + 5t FYM ha^{-1}	122.89	12.15	4.21	35.18
T_3: RDF + 2.5t FYM ha^{-1}	128.07	12.45	4.29	35.92
T_4: RDF + Hg @ 2.5kg ha^{-1}	132.22	14.91	4.56	35.96
T_5: RDF + HA @ 2.5 kg ha^{-1}	128.82	13.27	4.39	36.09
T_6: RDF + VC @ 2.5t ha^{-1}	138.27	16.31	4.90	35.88
T_7: RDF + FA @ 2.5 t ha^{-1}	126.56	13.62	4.51	35.91
SE (M) ±	**2.648**	**0.571**	**0.101**	**0.145**
CD @5 %	**8.16**	**1.76**	**0.31**	**0.45**
CV %	**10.36**	**11.32**	**3.98**	**3.53**

Table.2 Seed and oil yield of sunflower as influenced by different treatments (Pooled 2014 - 2017)

Treatments	Seed Yield $kgha^{-1}$				Oil Yield $kgha^{-1}$			
	14-15	15-16	16-17	Pooled	14-15	15-16	16-17	Pooled
T_1: RDF (80:60:30)	713	971	1713	1132	250	302	713	422
T_2: RDF + 5t FYM ha^{-1}	628	1082	1741	1150	210	335	719	421
T_3: RDF + 2.5t FYM ha^{-1}	614	1141	1775	1176	216	354	736	435
T_4: RDF + Hg @ 2.5kg ha^{-1}	643	1241	2096	1326	225	381	883	496
T_5: RDF + HA @ 2.5 kg ha^{-1}	589	1181	1998	1256	209	367	834	470
T_6: RDF + VC @ 2.5t ha^{-1}	670	1281	2154	1368	238	395	890	507
T_7: RDF + FA @ 2.5 t ha^{-1}	632	1205	1832	1223	225	372	756	451
SE (M) ±	**22.29**	**56.97**	**102.5**	**42.28**	**8.55**	**17.96**	**41.2**	**15.45**
CD @5 %	**70.21**	**175.55**	**315.8**	**130.27**	**26.36**	**55.36**	**126.9**	**47.60**
CV %	**8.16**	**8.53**	**9.34**	**9.94**	**9.60**	**8.69**	**9.03**	**9.85**

Table.3 Moisture % of sunflower (0-30 cm depth) as influenced by different treatments (Pooled 2014 - 2017)

Treatment	30 DAS	45 DAS	60 DAS	At harvest
T_1: RDF (80:60:30)	21.16	19.81	20.66	13.88
T_2: RDF + 5t FYM ha^{-1}	21.47	20.37	21.17	15.07
T_3: RDF + 2.5t FYM ha^{-1}	21.92	19.92	21.66	15.43
T_4: RDF + Hg @ 2.5kg ha^{-1}	24.41	25.60	25.24	17.54
T_5: RDF + HA @ 2.5 kg ha^{-1}	23.16	23.44	22.61	15.91
T_6: RDF + VC @ 2.5t ha^{-1}	29.85	25.02	25.09	17.31
T_7: RDF + FA @ 2.5 t ha^{-1}	23.84	22.05	23.05	15.53
SE (M) ±	**0.98**	**0.63**	**0.40**	**0.61**
CD @5 %	**3.03**	**1.94**	**1.23**	**1.89**
CV %	**9.20**	**8.88**	**10.05**	**9.72**

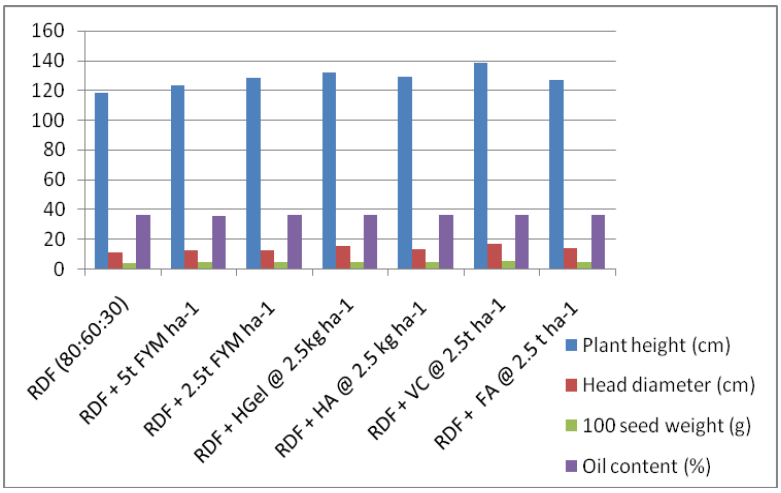

Fig. 1: Different growth yield contributing attributes

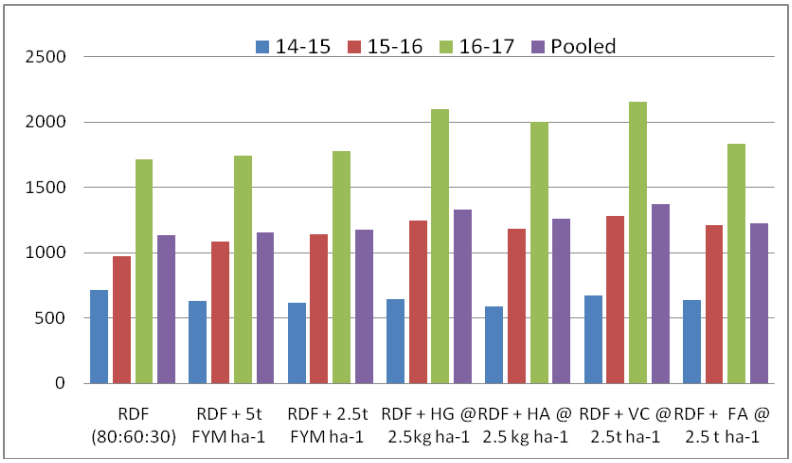

Fig. 2: Seed yield kg ha^{-1}

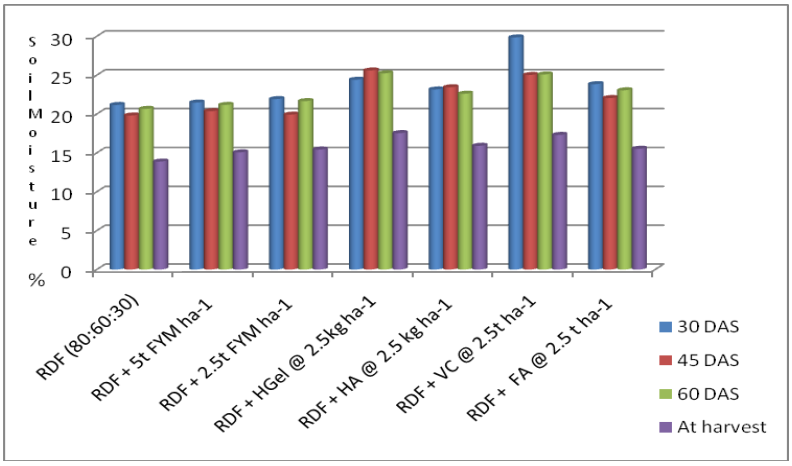

Fig.3: Soil moisture %

Lowest soil moisture % was observed with the application of 100 % RDF alone at all growth stages of sunflower. 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%. Use of hydrogel increased the amount of available moisture in the root zone resulting in longer intervals between irrigations and ultimately increases the yield of horticultural crops reported by EL-Hady *et al*., (2009).

Conclusions

1) Three years data and pooled results indicated that application of 100 % RDF + Vermicompost @ 2.5 t ha^{-1} (T6) found to be superior in recording significantly higher growth parameters, seed and oil yield of sunflower which was closely followed by application of 100 % RDF + hydrogel @ 2.5 kg ha^{-1}.

2) Higher moisture % in soil up to 30 cm depth was maintained with the application of 100 % RDF + hydrogel @ 2.5 kg ha^{-1} during maximum growth stages of sunflower.

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