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Studies on performance of safflower in problem soils with different agronomic management practices

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Abstract
A field experiment was conducted during *Rabi*, 2016 to study the performance of safflower crop in problem soils with different agronomic management practices at Alakapuram village farmer's field. The experiment was conducted in randomized block design on sandy clay loam soil with four replications. The treatments consisted of gypsum application, FYM + gypsum application, gypsum application + 25% extra recommended dose of nitrogen fertilizer and FYM + gypsum application + 25% extra recommended dose of nitrogen fertilizer with control *i.e* Farmers practice. The results indicated that significantly the lowest pH (8.0), electrical conductivity and the highest seed (436 kg ha^{-1}) and biological yield (1977 kg ha^{-1}) was recorded with gypsum + FYM + 25% extra nitrogen treatment when compared to farmers.

Keywords: Safflower crop, gypsum, FYM

Introduction
Out of the 329 m ha of total geographical area of India, the arid and semi-arid zones occupy more than one-third of the area (127.4 m ha). The salt affected soils occurring in these zones occupy 12 m ha area spread over in 15 states of the country out of which 4.12 m ha are alkali, 3.26 m ha are saline soil 4.62 m ha saline alkali soils. Among these salt affected soils, alkali soils are found to be highly problematic for crop production because of very poor physical and chemical environment particularly in irrigated areas. Sodicity problem in irrigated agriculture is becoming more serious because of faulty methods of irrigation, intensive cultivation of high water requirement crops, use of poor quality water, lack of adequate knowledge about soils and poor management practices. The amelioration of these alkali soils is not only expensive but also time consuming and laborious. (Gupta *et al*., 1995) [2]. Management practices which can be adopted to reduce negative effects of salts on plant growth includes leaching out salts from the soil profile, use of amendments such as gypsum, use of farmyard manure. Addition of organic amendments to soil improves soil properties and it is highly accepted by the farmers (Prapagar *et al*., 2012) [9]. Gypsum is the most commonly used amendment due to its availability at low cost. Joachim *et al*. (2007) [5] attributed the beneficial effect of combined use of farm yard manure and gypsum on the reclamation of sodic soils.
Safflower (*Carthamus tinctorius* L.) is considered to be a moderately salt-tolerant crop. There are very few reports about safflower resistance to salt stress or alkali stress (Liu & Baird, 2003) [3]. Salt content of 7 dSm^{-1} reduced safflower yield by 10-15% (Francois and Berstein, 1964). Safflower is a versatile crop that can be grown on a range of soil types, but comes up well on deep and well drained neutral to alkaline soils. Extensive deep root system combined with a long duration can break hard-pans and create channels in the soil profile thus facilitating air and water movement and benefit the management of soils prone to salinity (Houmanat, 2016) [4]. The study was carried out with a view to evaluate the performance of safflower crop in alkali soil under different agronomic management practices.

Materials and Methods
The field experiment was conducted during *rabi*, 2016 at Alakapuram village farmer's field on sandy clay loam soil in randomized block design with five treatments in four replications. The treatments consisted of control *i.e.* T1: Farmers practice, T2: Gypsum application, T3: FYM + Gypsum application, T4: Gypsum application + 25% of additional recommended dose of nitrogen fertilizer and T5: FYM + Gypsum application+25% of additional recommended dose of nitrogen fertilizer. Gypsum @ 10 t ha^{-1} and FYM @ 10 t ha^{-1} were incorporated as per the treatments before sowing of the safflower seed. Nitrogen @ 40 kg ha^{-1}, phosphorus @ 40 kg ha^{-1} and potassium @ 20 kg ha^{-1} were applied throug urea, single super phosphate and murate

of potash respectively. In farmers practice farmers were using gypsum @ 1 t ha^{-1}. Recommended agronomic management practices and plant protection measures were followed during crop growth period. The data recorded were analysed following standard statistical procedure.

Results and Discussion

Plant height (cm) and number of branches $plant^{-1}$

Plant height was significantly affected by different treatments. Maximum plant height (96.4 cm) was recorded with gypsum + FYM + 25% extra nitrogen applied treatment (T5) and found superior to farmers practice (Table 1) but on par with the application of gypsum+25% extra nitrogen (95.2 cm). The increase in plant height due to application of increased level of nitrogen might be due to stimulating effect of nitrogen on various physiological processes including cell division and cell elongation of the plant (Alim, 2012) [1]. The lowest plant height (71.4 cm) was recorded in farmers practice similarly highest number of branches were recorded in (11.2) followed by gypsum application + 25% extra recommended dose of nitrogen fertilizer (T4) lowest number of branches were recorded in farmers practice (4.9). Sipai *et al*. (2015) [12] reported that application of sulphur @ 60 kg ha^{-1} as gypsum resulted in significantly higher plant height, number of primary and secondary branches, number of siliqua per plant and test weight of mustard.

Number of heads $plant^{-1}$ and number of seeds $plant^{-1}$

Significantly maximum number of heads $plant^{-1}$ (25.2) were recorded in T_5 where as lowest (9) heads were observed in control treatment. Better availability of nutrients may result in better crop growth rate and ultimately more number of heads in safflower. Gypsum is the cheapest source of S which is known to significantly improve crop biometric parameters and yield (Mandal *et al*., 2005) [8] and also used as amendment in salt affected soils (Rathod *et al*., 2005) [11]. There were significant differences among the treatments in respect of number of seeds per head (Table 1). The maximum (44) seeds were recorded with FYM+ gypsum application + 25% additional dose of recommended nitrogen fertilizer (T5), whereas, the minimum (25) seeds per head were observed in T_1 (control).

Seed Yield

The maximum seed yield (436 kg ha^{-1}) was recorded by T_5 treatment *i.e* FYM+ gypsum application + 25% additional dose of recommended nitrogen fertilizer, followed by T_4 (330 kg ha^{-1}) *i.e* gypsum application + 25% additional recommended dose of nitrogen fertilizer. Lowest seed yield (181 kg ha^{-1}) seed yield was observed in T_1 (control). Gypsum although relatively less soluble, is a good source of S to oilseed crops. Gypsum as sulphur source significantly improved grain and stover yield of mustard compared to that of other S sources like elemental S and iron pyrite (Kumar *et al*., 1997). Gypsum applications (250 kg ha^{-1}) reflected in significant improvement in yield attributes and seed yield of Indian mustard (Rao and Shaktawat, 2002).

Biological Yield

Biological yield is a combination of seed yield and straw yield and is direct index of photosynthetic machinery. It becomes more important for multipurpose crop like safflower interms of seed yield and more drymatter used for fodder purpose. Maximum biological yield (1977 kg ha^{-1}) was recorded in T5 which was at par with T_4 treatment. Application of gypsum with organic manures is a less expensive alternative not only to improve soil condition but also to enhance crop yields. The addition of gypsum and organic manure to the saline and sodic soils has a synergistic effect between the two antagonists especially for monovalent cations such as Na+ (Mahmoodabadi *et al*., 2012) [7]. In a study by Hosmath *et al*. (2014) [3], 20 kg S ha^{-1} applied in the form of gypsum improved the yield of soybean by 12%. The oil content and quality also improved with application of S along with other nutrients.

Table 1: Influence of different management practices on growth and yield attributes of Safflower in alkali soils

Treatments	Plant height (cm)	No. of branches $plant^{-1}$	No. of heads $plant^{-1}$	No. of seeds $head^{-1}$
T_1- Farmers practice	71.4	4.9	9.0	25
T_2- Gypsum application	75.8	6.5	17.5	25
T_3- FYM + Gypsum application	83.3	8.0	17.8	30
T_4- Gypsum application + 25% extra recommended dose of nitrogen fertilizer	94.3	8.3	20.5	38
T_5-FYM+Gypsum application + 25% extra recommended dose of nitrogen fertilizer	96.4	11.2	25.2	44
SEm+	2.9	0.7	0.9	0.4
CD(0.05)	8.8	2.2	3.1	1.4
CV (%)	6.9	19.7	13.5	14.1

Table 2: Influence of different management practices on yield of safflower in alkali soils

Treatments	Seed yield (kg ha^{-1})	Biological yield (kg ha^{-1})
T_1- Farmers practice	181	991
T_2- Gypsum application	208	1126
T_3- FYM + Gypsum application	232	1208
T_4- Gypsum application + 25% extra recommended dose of nitrogen fertilizer	330	1515
T_5- FYM+ Gypsum application + 25% extra recommended dose of nitrogen fertilizer	436	1977
SEm+	54	62
CD(0.05)	163	190
CV (%)	12.3	9.8

Conclusion

The study concluded that there is a scope of increasing crop yields through use of integrated nutrient management. Application of gypsum + FYM + 25% additional nitrogen resulted in better yield attributing characters and yield followed by gypsum+25% additional nitrogen treatment while, the lowest yield was recorded in farmers practice.

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