# INFLUENCE OF GRADED LEVELS OF MACRO NUTRIENTS AND BIOFERTILIZERS ON SOIL HEALTH AND QUALITY OF SAFFLOWER IN VERTISOL


**ABSTRACT**

An investigation was carried out at farm of College of Agriculture Nagpur Maharashtra during, 2018-2019 to evaluate the soil fertility and quality of safflower. The experiment was laid out in Randomized Block Design (RBD) with three replication and nine treatments combination of FYM in Kharif season, biofertilizer and inorganic fertilizer at the time of sowing in rabi season using variety AKS/S-41. The result indicated that various physical properties as bulk density were decreases with increasing level of RDF with seed treatment Azospirillum + PSB and maximum water holding capacity increased with increasing level of RDF alone or in combination with Azospirillum + PSB. The changes in pH due to fertilizer application were significant. The changes in EC due to fertilizer (organic and inorganic) application were non-significant. The highest organic carbon, available NPK and S was recorded in the treatment of 100% RDF + Azospirillum + PSB and available Fe, Mn, Zn and Cu was recorded significantly highest in same treatment.



**Key words:** Azospirillum, *Biofertilizer, PSB, fertility, quality*.


## Introduction

India's major challenge during 21st century is to produce enough food, fodder, fibre, fuel so as to meet the diversified need of the burgoeing human and animal population of the country. This requirement can be achieved through enhanced productivity of diversified crops, using improved technology and increased cropping intensity (Sharma et. al., 2015) Among various factors responsible for low production of safflower oil is of prime importance. The increasing use of chemical fertilizers to increase oilseed production has been widely recognized but its long run impact on soil health, ecology and other natural resources are detrimental which affect living organisms including beneficial soil microorganisms and human being. Integration of mineral nutrient and bio fertilizer is an approach through which the management of plant nutrition and soil fertility in cropping and farming systems is adapted to site characteristics and to locally-available resources. It ensures that plant nutrition be environmentally, socially and economically viable. Concurrently it encourages, informs, trains and organizes farmers to increase crop production while sustaining soil productivity. Biofertilizers have also emerged promising components of nutrient supply system. Application of biofertilizers which is environment friendly and low cost input, plays significant role in plant nutrition. Among the nitrogen fixing bacteria, *Azotobacte*r, not only provides nitrogen, but also synthesizes growth promoting hormones such as IAA and GA (Ashima et al. 2017).

Safflower (*Carthamus tinctorius L*) is a herbaceous annual and a member of the Asteraceae/ Compositae family. It is native to parts of Asia, the Middle East, and Africa. It was grown mainly for its flowers, which were used in making dyes for clothing and food. Today, it is grown mainly for its oil. Safflower importance has been realized as an ideal oilseed crop due to its important character viz. capacity to with stand drought, low input required for its cultivation, no specific preference to any type of soil and its capacity to yield reasonably under rainfed condition. The oil contents various from 25 to 35 % depending upon varieties. The safflower oil is nutritionally better because it contains 78 % linoleic acid which is useful for the patient of heart disease and considered safe because unsaturated fatty acid, which is contain in it, lower the blood serum cholesterol. It also contains A, D, E and K vitamins. The linoleic acid in diet helps to prevent coronary disease. The safflower oil is also used to its drying properties; it is used in the manufacture of paints, varnishes, resins and linoleum.

It is an approach to soil fertility management that combines biofertilizer and mineral methods of soil fertilization with physical and biological measures for soil and water conservation. Chemical fertilizers alone application, supply only one or two nutrient elements to the crop. Moreover, the ever increasing prices of these fertilizers have discouraged the farmers to invest on these costly inputs. The integrated use of chemical fertilizers, and biofertilizer and other organics hold great promise in securing high level of crop productivity and also to protect soil health from deterioration and pollution hazards. The complementary use of chemical fertilizers, organic manures and biofertilizer is important to maintain and sustain a higher level of soil fertility and crop productivity. The continuous use of high level of chemical fertilizers leads to decrease the nutrient uptake of plants, resulting in either stagnation or decrease in yield and also causing environmental pollution (Manju Kumari and Diwakar Tripathi 2018). The continuous use of chemical fertilizers increase the concentration of heavy metals in the soil, disturb soil health and quality which can't support plant growth in long term basis. However in order to supplement the nutrient supply through chemical fertilizer as biofertilizers are cheaper, pollution free and renewable. Non symbiotic bacteria like Azotobactor and Azospirillium, fungus like Aspergillus have potential to fix nitrogen to number of non legume crops and phosphorus solubilizing bacteria (PSB) solubilize the unavailable phosphorus in soil to plant. While it can also produce antifungal compounds to fight against many plant pathogens. (Jen-Hshuan Chen, 2006). Among all the strategies of sustainable crop production, integrated nutrient management plays an important role through minimizing the chemical fertilizers and integrated with organic biofertilizer without affecting the soil quality and fertility (Singh and Sinsinwar, 2006).

Since, safflower is an important oilseed crop of Vidharbha under rain fed situation in vertisols. Intensive crop cultivation requires the use of chemical fertilizer but fertilizers are not only in short supply but also expensive. Therefore, current trend is to explore the possibility of supplementing chemical fertilizers with organic ones more particularly biofertilizers of microbial origin. The favourable responses of phosphate solubilizing biofertilizer and Azospirillum have been noticed by several workers. Keeping these considerations the present investigation was carried out for sustained safflower production.

## MATERIALS AND METHODS

A field experiment was conducted during 2012 at the College of Agriculture Nagpur located at $21^0$ 10' North Latitude and $79^0$ 10' East Latitude at the elevation of 321.26 m above sea level. The soil of the experimental site was clayey in nature with physical properties like Bulk density was 1.44 (0-15 cm) (Mg $m^{-3}$) (Black, 1965) and Maximum water holding capacity 48% (by wt) (Piper, 1966). Among the chemical properties was pH 7.75 (1:2 soil: water) (Piper, 1996), low in Ec (Piper, 1996), low in organic matter content of 0.5% (Jackson, 1967), low in available N (Kjeldah's method) (Subbiah and Asija, 1956), medium in available P (Jackson, 1967), medium in available K (Jackson, 1967) and low in available Sulphur (Jackson, 1967). Whereas micronutrient like Fe, Mn, Zn, Cu was estimated by the method described by Lindsay and Norvel (1978) and out of three Fe, Mn and Cu minor nutrient sufficient against the critical limit while available Zn was deficient against the critical limit at the start of experiment. The experiment was laid out in a Randomized Block Design (RBD) on the same site with three replications having nine treatment combinations, that is, T1 (control), T2 (50% RDF), T3 (50% RDF + Azospirillum + PSB), T4 (100% RDF), T5 (100% RDF + Azosprillum + PSB ), T6 (150% RDF), T7 (150% RDF + Azosprillum + PSB),T8 (50% RDF +2 % DAP spray at 30 and 45 DAS) and T9 (100% RDF +2 % DAP spray at 30 and 45 DAS). The fertilization N, P and K with biofertilizer were applied at 40:40:00 ha-1, respectively, while (FYM) was applied at 5 tons hectare. The fertilizers were applied as per treatment details. Dose of nitrogen and phosphorous were applied through Urea and SSP, respectively. Nitrogen was applied in two split doses, 1$^{st}$ dose at the time of sowing and 2$^{nd}$ at 30 DAS. Seed treatment of biofertilizers Azospirillum and PSB @ 250g /10 kg of seed at the time of sowing. The germination was completed between 6$^{th}$ to 10$^{th}$ days after Sowing

## Statistical analysis

Standard method of analysis known as 'Analysis of Variance' was applied for the standard analysis of the data, critical difference (CD) at 5 percent level of significance was worked out and use for comparison of different treatment (Gomez and Gomez, 1984).

## RESULTS AND DISCUSSION

### Effect of various treatments on physical properties of soil

The bulk density of soil was determined at harvest of crop and data presented in Table 1 under different treatment and it was ranged from 1.35 to 1.41 Mg m$^{-3}$. The bulk density of soil showed slightly changes but non-significant than initial value while Maximum water holding capacity was ranged from 48.20 to 57.50 %. The significantly highest value of maximum water holding capacity of soil was recorded by the treatment $T_5$ receiving 100% RDF + Azospirillum +

PSB followed by $T_7$ 150% RDF + Azospirillum + PSB. Treatment $T_6$ and $T_7$ found to be at par with treatment $T_5$. The lowest value of maximum water holding capacity was observed in control plot. It might be due to higher improvement because of build up humus and increased porosity of soil under treatments consisting of RDF and biofertilizers. The results are in conformity with the finding of Babhulkar *et al* (2000)

**Effect of various treatments on chemical properties of soil**

The results regarding pH and EC after harvest of safflower are present in Table 2. The pH value varied from 7.36 to 7.81 which was found minimum in $T_5$ treatment 100% RDF and seed treatment with Azospirillum + PSB. Electrical conductivity of soil showed slightly changes but non significant than initial values.

**Effect of various treatments on fertility status of soil**

The results regarding OC and available N, P, K and S after harvest of safflower are present in Table 3. Among the soil fertility parameters organic carbon content, available N, P, K and S in the soil after harvest of safflower under the influence of various treatments was significantly increased due to levels of RDF alone or incombination with Azospirillum + PSB application. The highest organic carbon content and available N, P, K and S in soil was recorded with the application of 100% RDF + Azospirillum + PSB followed by 150% RDF + Azospirillum + PSB. Treatment $T_5$ is found to significantly superior over all treatments. Lowest organic carbon content was recorded in control plot. The nutrient content may increase due to RDF and biofertilizer. Similar results were reported by Singh *et al.* (1986), Malevar and Hasanabade (1995). Marwha (1995) and Singh *et al* (1996) and Thakur and Sawarkar (2009).

**Effect of various treatments on available micronutrient of soil**

The results regarding micronutrient after harvest of safflower are present in Table 4. Available Fe, Mn, Zn and Cu content in soil after harvest of safflower was significantly increased with the increasing levels of RDF. Application of 100% RDF with seed treatment with Azospirillum + PSB showed highest values of available micronutrient content in soil followed by 150% RDF with seed treatment Azospirillum + PSB. The lowest available micronutrient content was observed in control plot. Similar results were found by Elkhoy *et al.* (2010). Who reported that the interaction between different nitrogen fertilizers (M.F. and compost) and biofertilizers were significantly increase the availability of (Fe, Mn, Zn and Cu) in the soil. The positive effect of biofertilizers on micronutrient availability may also due to optimum soil pH which facilite maximum available of micronutrient. While microorganisms released organic acids and enzymes, thus increase the availability of micronutrient in soil. Similar result were closely paint by Habashy *et al.* (2008).

**Quality Parameter of Safflower**

**Oil content**

The results regarding quality parameter like oil content of safflower are present in Table 5. The significant highest oil content i.e.32.89% was recorded by the treatment $T_5$ receiving 100% RDF with seed treatment of Azospirillum + PSB which was followed by treatment $T_7$ 150% RDF with seed treatment of Azospirillum + PSB i.e. 31.70%. Treatments $T_5$ and $T_7$, Treatments $T_{4,}$ $T_6$ and $T_8$ found to be at par with each other. Whereas, lowest oil content was obtained in control plot $T_1$. The increase oil content in safflower grains was might be due to application increased levels of RDF alone and incombination with Azospirillum + PSB, it create maximum oil content to the crop. The finding is substantiated by the result of Papi Reddy *et al.* (1994), Gawande *et al* (2005), Nimje (1991) and Patil and Sable (1997).

**CONCLUSION**

It may be concluded that Application of 100% RDF and seed treatment of Azospirillum + PSB found to be beneficial for safflower to nutritional quality, physical, chemical and fertility properties of soil .Which is build up soil NPK and maintained the fertility status of soil.Thus, application of fertilizer along with bio fertilizer can play a vital role in achieving its beneficial effect on nutrients supply and soil properties.

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**Table 1 :Effect of various treatments on physical properties of soil.**

| Treatments | | Bulk Density (Mg $m^{-3}$) | MWHC (%) |
|---|---|---|---|
| $T_1$ | Control | 1.41 | 48.20 |
| $T_2$ | 50% RDF | 1.39 | 51.12 |
| $T_3$ | 50% RDF + Azospirillum + PSB | 1.36 | 54.50 |
| $T_4$ | 100% RDF | 1.35 | 55.04 |
| $T_5$ | 100% RDF + Azospirillum + PSB | 1.36 | 57.50 |
| $T_6$ | 150% RDF | 1.40 | 56.22 |
| $T_7$ | 150% RDF + Azospirillum + PSB | 1.35 | 56.42 |
| $T_8$ | 50%RDF +2 % DAP spray at 30 and 45 DAS | 1.36 | 54.60 |
| $T_9$ | 100% RDF + 2% DAP spray at 30 and 45 days after sowing | 1.37 | 56.86 |
| | SE (m) ± | 0.0183 | 0.762 |
| | CD at 5% N.S | 0.0543 | 2.351 |



**Table 2: Effect of various treatments on chemical properties of soil.**

| Treatments | | pH (1:2.5) | EC (dS $m^{-1}$) |
|---|---|---|---|
| $T_1$ | Control | 7.67 | 0.41 |
| $T_2$ | 50% RDF | 7.81 | 0.36 |
| $T_3$ | 50% RDF + Azospirillum + PSB | 7.58 | 0.30 |
| $T_4$ | 100% RDF | 7.59 | 0.26 |
| $T_5$ | 100% RDF + Azospirillum + PSB | 7.36 | 0.25 |
| $T_6$ | 150% RDF | 7.42 | 0.34 |
| $T_7$ | 150% RDF + Azospirillum + PSB | 7.59 | 0.32 |
| $T_8$ | 50%RDF +2 % DAP spray at 30 and 45 DAS | 7.68 | 0.31 |
| $T_9$ | 100% RDF + 2% DAP spray at 30 and 45 days after sowing | 7.80 | 0.35 |
| | SE (m) ± | 0.225 | 0.050 |
| | CD at 5% | 0.677 | 0.151 |



**Table 3: Fertility status of soil after harvest of safflower**

| Treatments | | Organic carbon | Available nutrient | | | |
|---|---|---|---|---|---|---|
| | | g $kg^{-1}$ | N kg $ha^{-1}$ | P kg $ha^{-1}$ | K kg $ha^{-1}$ | S mg $kg^{-1}$ |
| $T_1$ | Control | 0.55 | 171.43 | 11.20 | 299.56 | 10.60 |
| $T_2$ | 50% RDF | 0.58 | 179.79 | 13.31 | 303.42 | 12.03 |
| $T_3$ | 50% RDF + Azospirillum + PSB | 0.61 | 234.15 | 14.52 | 310.16 | 12.78 |
| $T_4$ | 100% RDF | 0.63 | 200.70 | 16.87 | 352.77 | 15.21 |
| $T_5$ | 100% RDF + Azospirillum + PSB | 0.64 | 275.96 | 18.64 | 379.40 | 18.96 |
| $T_6$ | 150% RDF | 0.61 | 246.70 | 15.30 | 334.62 | 14.43 |
| $T_7$ | 150% RDF + Azospirillum + PSB | 0.62 | 200.70 | 16.13 | 323.61 | 13.86 |
| $T_8$ | 50%RDF +2 % DAP spray at 30 and 45 DAS | 0.60 | 204.88 | 14.29 | 341.17 | 12.84 |
| $T_9$ | 100% RDF + 2% DAP spray at 30 and 45 days after sowing | 0.57 | 171.43 | 15.63 | 336.89 | 14.82 |
| | SE (m) ± | 0.006 | 8.39 | 0.288 | 3.118 | 0.166 |
| | CD at 5% | 0.020 | 24.92 | 0.855 | 9.260 | 0.494 |

**Table 4: Available micronutrients status of soil after harvest of safflower as influenced by various treatment.**

| Treatments | | Available Micronutrients | | | |
|---|---|---|---|---|---|
| | | Fe (mg $kg^{-1}$) | Mn (mg $kg^{-1}$) | Zn (mg $kg^{-1}$) | Cu (mg $kg^{-1}$) |
| $T_1$ | Control | 5.82 | 3.68 | 0.66 | 1.54 |
| $T_2$ | 50% RDF | 6.54 | 4.45 | 0.97 | 1.60 |
| $T_3$ | 50% RDF + Azospirillum + PSB | 6.87 | 4.79 | 1.20 | 1.65 |
| $T_4$ | 100% RDF | 6.17 | 4.89 | 1.11 | 1.65 |
| $T_5$ | 100% RDF + Azospirillum + PSB | 7.39 | 5.75 | 1.53 | 1.79 |
| $T_6$ | 150% RDF | 7.11 | 5.29 | 1.27 | 1.69 |
| $T_7$ | 150% RDF + Azospirillum + PSB | 7.27 | 5.42 | 1.47 | 1.71 |
| $T_8$ | 50%RDF +2 % DAP spray at 30 and 45 DAS | 6.36 | 4.33 | 1.01 | 1.61 |
| $T_9$ | 100% RDF + 2% DAP spray at 30 and 45 DAS | 6.79 | 4.84 | .098 | 1.69 |
| | SE (m) ± | 0.094 | 0.188 | 0.033 | 0.08 |
| | CD at 5% | 0.280 | 0.550 | 0.098 | 0.23 |

**Table 5: Effect of graded level of major nutrients and biofertilizers on quality parameters of safflower.**

| Treatments | | Oil (%) |
|---|---|---|
| $T_1$ | Control | 29.15 |
| $T_2$ | 50% RDF | 29.85 |
| $T_3$ | 50% RDF + Azospirillum + PSB | 30.01 |
| $T_4$ | 100% RDF | 31.70 |
| $T_5$ | 100% RDF + Azospirillum + PSB | 32.89 |
| $T_6$ | 150% RDF | 32.27 |
| $T_7$ | 150% RDF + Azospirillum + PSB | 31.42 |
| $T_8$ | 50%RDF +2 % DAP spray at 30 and 45 DAS | 30.45 |
| $T_9$ | 100% RDF + 2% DAP spray at 30 and 45 days after sowing | 30.49 |
| | SE (m) ± | 0.883 |
| | CD at 5% | 2.623 |