International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(6): 663-667

Received: 16-09-2019
Accepted: 18-10-2019

SB Dahiphale
College of Agriculture, Badnapur, VNMKV, Parbhani, Maharashtra, India

VK Adsure
College of Agriculture, Badnapur, VNMKV, Parbhani, Maharashtra, India

SR Rathod
College of agriculture Nagpur, Maharashtra, India

Corresponding Author:
SB Dahiphale
College of Agriculture, Badnapur, VNMKV, Parbhani, Maharashtra, India

Effect of single and dual bio-inoculants on chemical properties &nutrient availability in soil after harvest of sunflower

SB Dahiphale, VK Adsure and SR Rathod

Abstract
Biofertilizers are the alternate sources to meet the nutrient requirement of crops). Biofertilizer like *Azotobacter* fix atmospheric nitrogen. PSB plays a vital role for making unavailable phosphorus to available phosphorus by mineralization of organic phosphate or by solubilization of inorganic phosphate by production of acids.
The nutrient availability after harvest of sunflower noted significantly better in bioinoculant treated plots as compared to uninoculated control and only RDF. Through, liquid inoculants showed better performance but carrier based bioinoculants were also found equally at par with the respective N-fixer and P-solubilizer treatments).

Keywords: Bio-inoculants, pH, Ec, $CaCo_3$, nutrient, sunflower

Introduction

Sunflower (*Helianthus annus*) member is of the family Asteraceae (compositae), native to Southern part of USA. Itis popularly known as "Surajmukhi." The name "Helianthus" is derivedfrom 'Helios' meaning 'sun' and 'anthos' meaning 'flower'. It is one of thefastest growing oilseed crops in India. This crop has gained importance due to its short duration of maturity, containing excellent quality oil, photo-insensitivity, wide adaptability in different agro-climatic region and different kinds of cropping patterns and drought tolerance. It is one of the most important oil seeds crops in the worlds seed production. Oil seeds crops are known as the source of energy and protein. They are important in human andlivestock nutrition and play vital role in the economy of some countries.

One of the important oil seed crop is sunflower which contains 40-50% oil and 15-21% protein. Sunflower oil also has excellent nutritional properties. It is practically free of significant toxic compounds and has a relatively high concentration of linoleic acid. This polyunsaturated fatty acid is an essential fatty acid (not synthesized by humans), and is the precursor of gamma-linolenic and arachidonic acids (Seiler 2007) [14]. Because of sunflower versatile nature is expected to play a crucial role in the oilseed economy of the country. In India during 2014-15 sunflower was cultivated on 5.52 lakh hectare area with a production of 4.15 lakh tones. The average yield of 752 kg/ha was one of the lowest in world (Anonymous, 2015-2016). In Maharashtra sunflower is cultivated on an area of 0.47 lakh hectare with production of 0.20 lakh tones with a productivity of 425 kg/ha induring the year 2015-2016.

Liquid inoculants are special formulation containing desired microorganisms in viable form, their nutrients and certain chemicals primarily function as microbial cell protectant and amendments that promote cell survival during storage and after application to seed or soil. Various liquid media have been used to prepare the liquid biofertilizers of rhizobia (Singleton, *et al*. 2002) [12]. These media normally consists of carbon, nitrogen and vitamin sources, which promote the growth of bacteria. However, some additives have been identified for development of liquid inoculants based on their ability to protect rhizobial cells during storage and on seeds at extreme conditions likes high temperature, desiccation and in presence of toxic seed exudates.

Treatments

T1: Un-inoculated and unfertilized (control)
T2: Only RDF (60:40:30 kg N, P2O5 and K2O ha-1)

Carrier based inoculants (with RDF)
T3: RDF + *Azotobacter*
T4: RDF + *Bacillus megaterium* (PSB)
T5: RDF + *Azotobacter* + *Bacillus megaterium* (PSB)

Liquid inoculants (with RDF)
T6: RDF + *Azotobacter*
T7: RDF + *Bacillus megaterium* (PSB)
T8: RDF + *Azotobacter*. + *Bacillus megaterium* (PSB)

Material and Methods
The treatments comprising inoculation with carrier based and liquid inoculants of *Azotobacter* and *Bacillus megaterium* (PSB) for sunflower, used in alone and in combinations. Total eight treatments of bioinoculants were replicated three times in RBD. Seed treatment was done immediate before sowing with carrier based bioinoculants @ 250 g 10 kg-1 seed and liquid bioinoculants @ 100 ml 10 kg-1 seed. The crop was cultivated following recommended agronomic practices. The recommended dose of chemical fertilizers were applied at the time of sowing. Intercultural operations like thinning, weeding, spraying of insecticides, fertilizer application and schedule of irrigation for sunflower crop was carefully followed.

Soil pH
It was determined in (1:2.5) soil water suspension using digital pH meter (Jackson, 1973) [4].

Digital electronic conductivity
It was estimated in (1:2.5) soil: water ratio using conductivity meter (Jackson, 1973) [4].

Organic carbon
Organic carbon in soil was estimated by Walkley and Black's rapid titration method as described by Jacksons (1973) [4].

Calcium carbonate
The free calcium carbonate was determined by rapid titration method as outlined by Piper (1966) [9].

Available nitrogen
It was estimated by using alkaline permanganate method as suggested by Subbiah and Asija (1956).

Available phosphorus
It was determined by using 0.5 M sodium bicarbonate as an extractant as outlined by Olsen *et al.* (1954) [16].

Available potassium
It was determined by using normal ammonium acetate as an extractant and measured on flame photometer Jacksons (1973) [4].

DTPA extractable zinc and iron
DTPA extractable zinc and iron in soil was estimated as per procedure described by Lindsay and Norvell (1978).

Result and Discussion
The data noted in Table 1.indicates fig (1, 2, 3) shows the significant increase in nutrient availability in soil after harvest of sunflower crop was also recorded with bioinoculants. Significantly the highest values of available K_2O were noted in treatment receiving both the inoculants along with RDF in carrier based form. However, in case of available N treatment T5 and T8 were found statistically at par with each other and available P_2O_5 was found maximum in dual inoculation with carrier based T5, T6 and T7 and liquid sources (T8) which were noted statistically at par with each other.

Table 1: Effect of liquid and carrier based bioinoculants on nutrient availability in soil after harvest of sunflower

Sr. No.	Treatment	Available N (kg ha^{-1})	Available P_2O_5 (kg ha^{-1})	Available K_2O (kg ha^{-1})
T1	Uninoculated and unfertilized (Control)	141.33	13.50	598
T2	Only RDF (60:40:30 kg NPK / ha^{-1})	156.20	15.54	614
	Carrier based inoculants			
T3	RDF + *Azotobacter*	165.67	16.02	640
T4	RDF + *Bacillus megaterium* (PSB)	160.42	16.49	643
T5	RDF + *Azotobacter* + *Bacillus megaterium* (PSB)	174.00	17.35	656
	Liquid inoculants			
T6	RDF + *Azotobacter*	166.67	16.71	649
T7	RDF + *Bacillus megaterium* (PSB)	164.30	16.91	647
T8	RDF + *Azotobacter* +*Bacillus megaterium* (PSB)	187.65	18.04	655
	S.E.±	3.76	0.49	19.04
	C.D. at 5 %	11.36	1.50	NS
	C.V. %	3.96	5.29	5.17

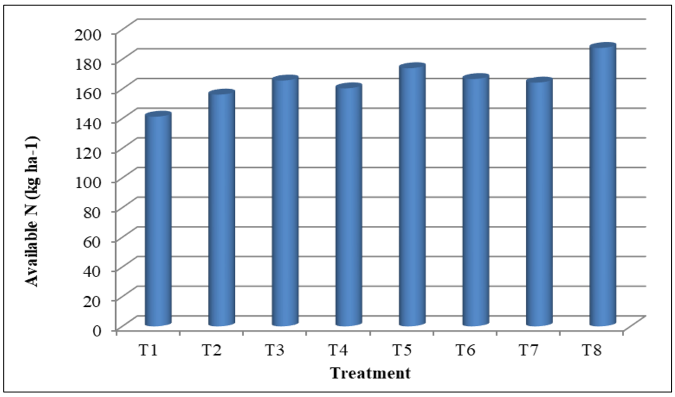

Fig 1: Available Nitrogen

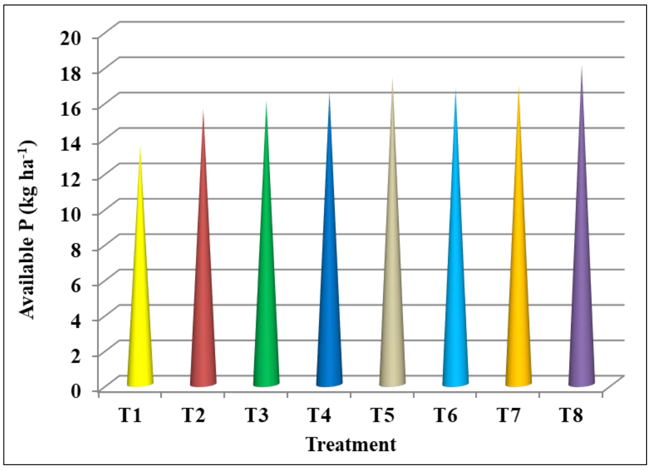

Fig 2: Available Phosphorus

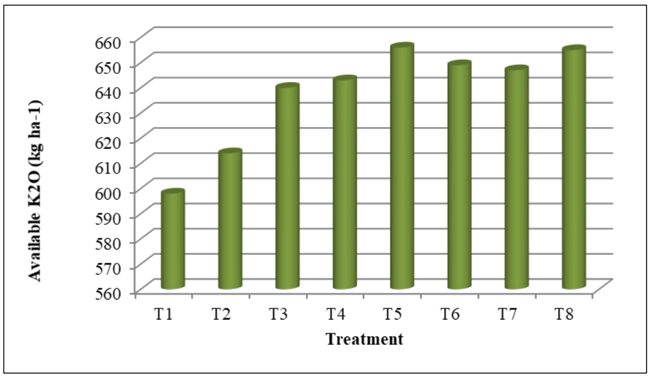

Fig 3: Available Potassium

The 100% RDF + dual inoculation treated plots showed the highest increased in available nitrogen which might be due to the direct addition of nitrogen through fertilizers to available pool of soil. This increase in available N might also be attributed to the greater multiplication of soil microbes which converts organically bound N to inorganic from as reported by Katkar *et al*. (2006). Increase in soil available nitrogen due to *Rhizobium* and *Azotobacter* inoculation and available P due to phosphorus solubilizing bacteria inoculation was also documented by Gupta (2006) [3]. Further, Nirmal (2006) [8] reported that the dual inoculation of *Rhizobium* and PSB resulted more availability of soil N and P because of their associative effect plus solubilization from non-exchangable to labile form. The PSB secretes different organic acids like citric acid and malic acid which act on insoluble phosphate to convert them into soluble phosphate near the root of the plant and hence availability of phosphorus increased. Further Kumar *et al*. (1998) [6] has also reported that seed inoculation with PSB significantly increased the available P in soil after harvest of sunflower might due to releasing native P as well as in protecting fixation of added phosphorus. However, the reason for more availability of K might be ascribed to and disintegration of K minerals due to reduction of K fixation and its release in K available pool of the soil. Similar findings were reported by Bellaki and Badanur (1997) [1]. Swaroop (2006) [13] noted that the available potassium was maximum with the application of *Rhizobium* inoculation + 20 kg N ha^{-1}. Further, Katkar *et al.* (2002) [5] reported that use of organic sources either alone or in combination with chemical fertilizer recorded higher available potassium in the soil.

The data pertaining to available phosphorus revealed that dual inoculation recorded higher available phosphorus as compared to single inoculation of *Azotobacter* and PSB. While effectiveness of PSB inoculation was superior over *Azotobacter* inoculation. This might be due to beneficial effect of phosphate solubilizing microorganisms which played a major role in solubilization of native and applied soil phosphorus and increased availability of P in soil.

Effect of liquid and carrier based bioinoculants on available micronutrients in soil after harvest of sunflower

The scrutiny of results presented in Table 2. and depicted in fig. (4 and 5) shown reveals that the available micronutrients (Fe and Zn) in soil after harvest of sunflower crop were also found significantly higher. Available Fe was noted maximum in treatment receiving both the inoculants along with RDF in liquid form. However, available Zn in dual inoculation which was at par with T5 and T7 treatments and liquid source (T8) was noted statistically at par with each other.

Table 2: Effect of liquid and carrier based bio-inoculants on available micronutrients in soil after harvest of sunflower

Sr. No.	Treatment	Available Zn (mg kg $^{-1}$)	Available Fe (mg kg $^{-1}$)
T1	Uninoculated and unfertilized (Control)	0.51	4.26
T2	Only RDF (30:60:30 kg NPK / ha^{-1})	0.55	4.58
Carrier based inoculants			
T3	RDF + *Azotobacter*	0.58	4.65
T4	RDF + *Bacillus megaterium (PSB)*	0.62	4.77
T5	RDF + *Azotobacter* + *Bacillus megaterium* (PSB)	0.67	5.13
Liquid inoculants			
T6	RDF + *Azotobacter*	0.63	5.18
T7	RDF + *Bacillus megaterium* (PSB)	0.68	4.89
T8	RDF + *Azotobacter* + *Bacillus megaterium* (PSB)	0.70	5.35
	S.E. ±	0.009	0.056
	C.D. at 5 %	0.029	0.169
	C.V. %	2.69	2.02

The bacteria in soil possess surfaces that interact strongly with metal ions in soil solution. They could absorb a greater amount of heavy metals than inorganic soil components such as montmoillonite, Kaolinite or vermiculite (Ledin *et al.*, 1996) [7]. Further, Treeby *et al.* (1989) indicates that phytosiderophores are capable of increasing the amount of complex edcations in solution. Further, Chand and Somani (2003) [2] revealed that effective use of FYM, biofertilizers along with chemical fertilizers improved Fe and Zn content in mustard.

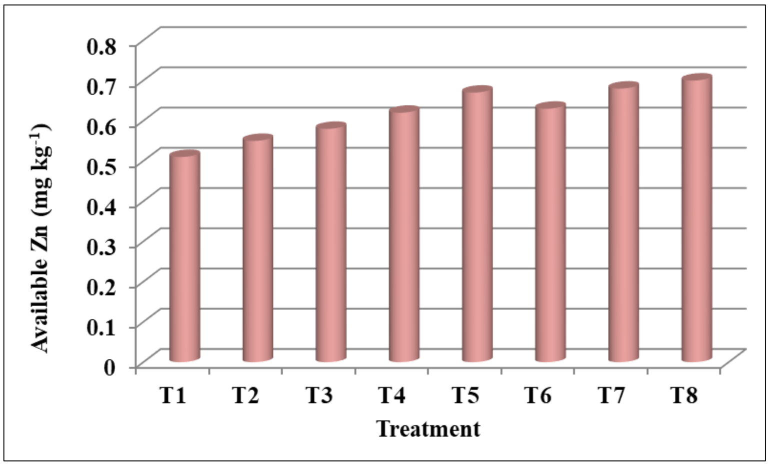

Fig 4: Available Zn

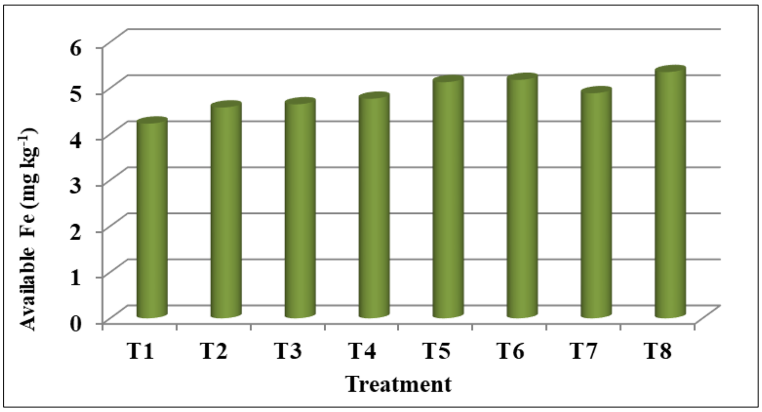

Fig 5: Available Fe

Effect of liquid and carrier based bioinoculants on chemical properties in soil after harvest of sunflower

The results presented in Table 3.regarding changes in soil pH, EC and $CaCO_3$ after harvest of sunflower indicates non-significant results. The organic carbon in sunflower crop was influenced significantly with the seed inoculation with *Azotobacter* +PSB along with RDF as compared to control. However in case of organic carbon in dual inoculation with liquid sources T8 were noted statistically at par with T5 and T6 treatments.

Table 3: Effect of liquid and carrier based bioinoculants on chemical properties in soil after harvest of sunflower

Sr. No.	Treatment	Ph (1:2.5)	EC (dSm^{-1})	Caco3 (g kg^{-1})	Organic Carbon (g kg^{-1})
T1	Uninoculated and unfertilized (Control)	7.78	0.26	43.19	4.72
T2	Only RDF (60:40:30 kg NPK / ha^{-1})	7.79	0.28	43.34	5.19
Carrier based inoculants					
T3	RDF + *Azotobacter*	7.79	0.28	43.15	5.75
T4	RDF + *Bacillus megaterium (PSB)*	7.78	0.27	43.00	5.34
T5	RDF + *Azotobacter* + *Bacillus megaterium* (PSB)	7.78	0.27	43.40	5.96
Liquid inoculants					
T6	RDF + *Azotobacter*	7.79	0.26	42.59	5.82
T7	RDF + *Bacillus megaterium* (PSB)	7.78	0.26	42.40	5.54
T8	RDF + *Azotobacter* + *Bacillus megaterium* (PSB)	7.78	0.25	42.40	6.04
	S.E. ±	0.11	0.011	1.69	0.10
	C.D. at 5 %	NS	NS	NS	0.329
	C.V. %	2.49	7.66	6.84	3.41

The observations recorded on soil organic carbon (g kg^{-1}) indicated that there was significant increase in OC at harvest. This could be attributed to the addition of organic materials of plants and roots which increased activity of microbes and also due to better root penetration. Soil available P resulting in better root growth consecutively leading to accumulation of organic matter in rhizosphere (Qureshi and Narayansamy 2005) [10]. Santhy *et al.* (2001) [11] reported that the addition of crop residues, over two decades resulted in the higher organic carbon content, improved crop growth and yield when compared to unfertilized control plots.

Conclusion

The significant increase in nutrient availability in soil after harvest of sunflower crop was also recorded with bioinoculants. Significantly higher values of available potassium was noted in treatment receiving both the inoculants along with RDF in carrier based form. However, in case of available nitrogen highest in treatment T8 and available phosphorus was found maximum in dual inoculation with carrier based T5 and liquid sources (T8) which were noted statistically at par with each other.

The available micronutrients (Fe and Zn) in soil after harvest of sunflower crop were also found significantly highest. Available Fe was noted maximum in treatment receiving both the inoculants along with RDF in liquid form. However, available Zn was significantly higher in dual inoculation with liquid source (T8).

Soil pH, EC and CaCO3 after harvest of sunflower indicated non-significant results. The soil organic carbon in sunflower crop was also influenced significantly with the seed inoculation of *Azotobacter* and PSB along with RDF as compared to control. However, in case of organic carbon in dual inoculation with liquid sources (T8) were noted statistically at par with T5 and T6 treatments.

References

1. Bellaki MA, Badanur VP. Long term effect of integrated nutrient management on properties of vertisol under dryland agriculture. J Indian Soc. Soil Sci. 1997; 45(3):438-442.
2. Chand S, Somani LL. Balance use of fertilizers, organics and biofertilizer in mustard. Int. J Trop. Agric. 2003; 21(1-4):133-140.
3. Gupta SC. Effect of combined inoculation on nodulation, nutrient uptake and yield of chickpea in vertisols. J Indian Soc. Soil Sci. 2006; 54(2):251-254.
4. Jackson ML. Soil Chemical Analysis. Prentice Hall of India Private Ltd, 1973.
5. Katkar RN, Tukhede AB, Sonlanke VM, Wankhede ST, Patil MR. Effect of integrated management of organic manures and fertilizers on soil properties and cotton yield. Cotton Res. Dev. 2002; 16(1):89-92.
6. Kumar M, Yadav K, Thakur SK, Mandal K. Effect of vesicular *Arbuscular mycorriza* fungi and *Rhizobium* inoculation on nodulation root colonization, nitrogen fixation and yield of chickpea. J Indian Soc. Soil Sci. 1998; 46(3):375-378.
7. Ledin M, Rulecker K, Allard B. Zn, Cd, and Hg accumulation by microorganisms, organic and inorganic soil components in multi-compartment system. Soil Biol. Biochem. 1996; 28:791-799.
8. Nirmal D, Singh RK, Kumar A, Singh J. Effect of organic inputs and biofertilizers on biomass, quality and yield parameters of vegetable pea (*Pisum sativum* L.). Int. J Agric. Sci. 2006; 2(2):618-620.
9. Piper CS. Soil and Plant Analysis. Hans Publishers, Bombay, 1966, 368.
10. Qureshi AA, Narayanasamy G. Residual effect of phosphate rocks on the dry matter yield and P uptake of mustard and wheat crops. J Indian Soc. Soil Sci. 2005; 53(1):132-134.
11. Santhy P, Muthvel P, Selvi D. Status and impact of organic matter fractions on yield, uptake and available nutrients in a long term fertilizer experiment. J Indian Soc. Soil Sci. 2001; 49(2):281-285.
12. Singleton P, Keyser H, Herridge D. Development and evaluation of liquid inoculant. In: Inoculants and nitrogen fixation of legumes in Vietnam. D. Herridge (ed.) ACIAR Proceeding. 2002; 109:67-74.
13. Swaroop K. Effect of phosphorus, potash and *Rhizobium* on pod yield, nutrient uptake and residual available soil NPK of vegetable cowpea. Ann. Agric. Res. 2006; 27(3):250-256.
14. Seiler GJ. Wild annual *Helianthus annus* and *H. deserticola* for improving oil content and quality in sunflower. Indian Crop Prod. 2007; 25:95-100.
15. Seiler GJ. Wild annual *Helianthus annus* and *H. deserticola* for improving oil content and quality in sunflower. Indian Crop Prod. 2007; 25:95-100.
16. Olsen SR, Cole CV, Watanabe FS, Dean E. Estimation of available phosphorus by extraction with $NaHCO_3$. Cir. 939, U.S. Dept. Agric., 1954, 19-20.