

Original Research Article

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Effect of Integrated Nutrient Management (INM) practices on Nutrients Uptake by Safflower and Nutrients status in Vertisol Soil

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ABSTRACT

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A field experiment was conducted at Agricultural Research Station, Annigeri, University of Agricultural Sciences, Dharwad during *rabi* season of 2015-16 under rainfed condition to study the effect of integrated nutrient management (INM) practices on nutrients uptake by safflower and nutrients status in Vertisol Soil in safflower crop. Results indicated that among the different INM combinations tested, application of RDF (40:40:12 kg ha⁻¹ NPK) + 2.0 t ha⁻¹ Vermicompost + *Azospirillum* + PSB + ZnSO₄@ 10.0 kg ha⁻¹ (T₁₀) recorded significantly highest nutrient content and uptake of nitrogen (33.75 and 36.70 Kg ha⁻¹) phosphorus (8.72 and 15.67 Kg ha⁻¹) and potassium (20.72 and 34.97 Kg ha⁻¹) at 60 DAS and at harvest respectively. The available nutrients content of N, P₂O₅ and K₂O in soil at harvest were also recorded significantly higher in treatment T₁₀ (application of RDF (40:40:12 kg ha⁻¹ NPK) + 2.0 t ha⁻¹ Vermicompost + *Azospirillum* + PSB + ZnSO₄@ 10.0 kg ha⁻¹).

Introduction

Safflower (*Carthamus tinctorius* L.) is one of the oldest crops cultivated for its edible seed oil and is known for drought tolerance due to its partially xerophytic, spiny nature and deep root system. As this crop is mainly cultivated under rainfed conditions during post-rainy season on receding soil moisture, inadequate supply of both water and nutrients affect nutrient uptake.

Application of limited quantity of nutrients (NPK) only through chemical fertilizer creates multiple-nutrients deficiencies in the soil which is considered as one of reason for limiting the crop production (Tiwari *et al.*,

2002). Hence, there is need to be improved the soil fertility for better yield. Thus, soil fertility as well as crop production can be improved by application of nutrients through organic sources and/or integration of different organic sources of nutrients (Reddy 2005, Akbari *et al.*, 2011; Basak *et al.*, 2012). Nutrients are very much essential for growth and development of safflower and these deficiency leads to decrease the crop yield. Therefore, it is necessary to know the uptake of nutrients by crop and nutrients status in vertisol soil. Thus, this research was conducted with the objective of to study the effect of integrated nutrient management

(INM) practices on nutrients uptake by safflower and nutrients status in vertisol soil.

Materials and Methods

A field experiment was conducted at the Agricultural Research Station, Annigeri, University of Agricultural Sciences, Dharwad, during *rabi* season of 2015-16. The experiment was laid out in a randomized complete block design (RCBD) with three replications and ten treatments comprising, T₁ - RDF (40:40:12 kg ha⁻¹ NPK) + FYM (5.0 t ha⁻¹), T₂ - RDF (40:40:12 kg ha⁻¹ NPK) alone, T₃ - 50% RDF + 1.0 t ha⁻¹ Vermicompost + *Azospirillum* + PSB, T₄ - RDF + 1.0 t ha⁻¹ Vermicompost + *Azospirillum* + PSB, T₅ - 50% RDF + 2.0 t ha⁻¹ Vermicompost + *Azospirillum* + PSB, T₆ - RDF + 2.0 t ha⁻¹ Vermicompost + *Azospirillum* + PSB, T₇ - 50% RDF + 1.0 t ha⁻¹ Vermicompost + *Azospirillum* + PSB + ZnSO₄ 10.0 kg ha⁻¹ T₈ - RDF + 1.0 t ha⁻¹ Vermicompost + *Azospirillum* + PSB + ZnSO₄ @ 10.0 kg ha⁻¹, T₉ - 50% RDF + 2.0 t ha⁻¹ Vermicompost + *Azospirillum* + PSB + ZnSO₄ @ 10.0 kg ha⁻¹ and T₁₀ - RDF + 2.0 t ha⁻¹ Vermicompost + *Azospirillum* + PSB + ZnSO₄ @ 10.0 kg ha⁻¹.

The soil of the experimental field was clayey in texture and soil in low, low and high rating for available nitrogen (224 kg N ha⁻¹) (Kjeldal method), available phosphorus (20.86 kg P₂O₅ ha⁻¹) (Olesen's method) and available potassium (342 kg K₂O ha⁻¹) (Flame photometric method), respectively. The soil was found slightly alkaline (pH 7.95) (Potentiometric method) with normal electric conductivity. Urea, single super phosphate, muriate of potash and zinc sulphate as chemical sources of nutrients, and FYM, Vermicompost, *Azospirillum*, and PSB as organic and biofertilizer sources were used in different combinations to make 10 treatments as mentioned above. The chemical fertilizers were applied as basal at the time of sowing

and for seed treatment the seeds of safflower were coated with *Azospirillum* and PSB one hour before sowing and they were air dried under shade whereas the organic manures were applied three weeks before sowing of safflower. Safflower variety- Annigeri-1 was sown in the second week of October and harvested in the third week of February. Rainfall received during 2015-16 was 507.20 mm which was 67.24 % lower than the long-term average of 754.90 mm. During the crop growth period from October to February only 38 mm rainfall received in October month at the time of sowing. Further, no rainfall was received during the crop growth period.

Estimation of N, P and K uptake by crop

To estimate the uptake of N, P and K, samples were collected 60 DAS and at harvest for weeds and only at harvest for crop. The samples were oven dried at 65⁰ C and ground in Willey mill to pass through two mm sieve. The two mm sieved samples were used for the estimation of nitrogen, phosphorus and potassium content in crop and weeds.

Nitrogen uptake by crop and weeds were determined by digesting the plant samples with suitable acid mixture of concentrated sulphuric acid. The digested samples were distilled by Micro Kjeldahl method in an alkaline condition and titrated against standard acid Piper (2002). Phosphorus was estimated by Vanedomolybdate method in diacid mixture as detailed by Jackson (1973). The intensity of the colour developed was measured in a spectrophotometer, using blue filter. Potassium content was estimated from diacid digest material using Flame Photometer as described by Muhr *et al.*, (1965) and was expressed as percentage K. The nutrient content and dry weight were used to calculate the total uptake of nutrients (N P K) and expressed in kg ha⁻¹.

$$\text{Nutrient uptake (kg ha}^{-1}\text{)} = \frac{\text{Nutrient content (\%)}}{100} \times \text{Dry weight (kg ha}^{-1}\text{)}$$

The soil samples were collected (0-30 cm depth) after harvest of safflower from each plot and analysed for available N 0.32% alkaline KMnO_4 oxidizable (Kjeldahl method), available P_2O_5 0.5 M NaHCO_3 extractable at pH 8.5 (Olesen's method) and K_2O Neutral normal ammonium acetate extractable (Flame photometric method).

Results and Discussion

Nutrients (NPK) uptake by crop

Nutrient (N, P and K) uptake by crop varied significantly among various nutrients management treatments at 60 DAS and at harvest (Table 1).

Results indicated that among the different INM combinations tested, application of RDF (40:40:12 kg ha^{-1} NPK) + 2.0 t ha^{-1} Vermicompost + *Azospirillum* + PSB + ZnSO_4 @ 10.0 kg ha^{-1} (T_{10}) recorded significantly highest nutrient content and uptake of nitrogen (33.75 and 36.70 Kg ha^{-1}) phosphorus (8.72 and 15.67 Kg ha^{-1}) and potassium (20.72 and 34.97 Kg ha^{-1}) at 60 DAS and at harvest respectively, but integrated nutrients management treatments T_6 , T_7 , T_8 and T_9 found to be at par with T_{10} . Significantly higher uptake of nitrogen, phosphorus and potassium by safflower in these treatments might be due to integrated source of nutrients helped in better translocation of nitrogen, phosphorus and potassium from soil to plant and its release from organic amendments over a longer period of time.

Thus, direct as well as residual effect of manures and chemical fertilizer helped in uptake of nutrients. The results are in conformity with findings of Bharadwaj *et al.*, (2008) and Raju *et al.*, (2013). In addition to above, Vermicompost also may be enhanced soil moisture retention and its supply during the crop growth, which in turn improved nutrient uptake by the crop.

Nutrients (NPK) status in soil

The soil available N, P_2O_5 and K_2O were significantly influenced due to different integrated treatments after harvesting of safflower are presented in Table 2. Results indicated that among the different INM combinations tested, application of RDF (40:40:12 kg ha^{-1} NPK) + 2.0 t ha^{-1} Vermicompost + *Azospirillum* + PSB + ZnSO_4 @ 10.0 kg ha^{-1} (T_{10}) recorded significantly highest values of soil available N (229.60 kg ha^{-1}), P_2O_5 (25.29 kg ha^{-1}) and K_2O (320.42 kg ha^{-1}), but integrated nutrients management treatments T_6 , T_7 , T_8 and T_9 found to be at par with T_{10} . Similar beneficial effects of organic sources as well as integration of different sources of nutrients on soil fertility were also recorded by Akbari *et al.*, (2011), Basak *et al.*, (2012) and Tamboli *et al.*, (2014).

Conclusion based on results of the field experimentation, it seems logical to conclude that profitable, potential and effective nutrient management in safflower by integrated nutrients management practices can be achieved by application of RDF (40:40:12 kg ha^{-1} NPK) + 2.0 t ha^{-1} Vermicompost + *Azospirillum* + PSB + ZnSO_4 @ 10.0 kg ha^{-1} .

Table.1 Nitrogen, phosphorus and potash content (%) and uptake (kg ha⁻¹) by safflower as influenced by INM treatments

Treatment	At 60 DAS						At harvest					
	Nutrient content (%)			Uptake (kg ha ⁻¹)			Nutrient content (%)			Uptake (kg ha ⁻¹)		
	N	P	K	N	P	K	N	P	K	N	P	K
T ₁ - RDF (40:40:12 kg ha ⁻¹ NPK) + FYM (5.0 t ha ⁻¹)	0.54	0.10	0.37	19.38	3.49	13.47	0.70	0.20	0.67	24.72	7.20	24.21
T ₂ - RDF (40:40:12 kg ha ⁻¹ NPK)	0.52	0.09	0.36	17.70	3.03	12.39	0.69	0.16	0.62	23.14	5.54	21.09
T ₃ - 50 % RDF + 1.0 t ha ⁻¹ VC + <i>Azospirillum</i> + PSB	0.61	0.12	0.40	22.58	4.51	14.74	0.73	0.28	0.69	26.89	10.45	25.72
T ₄ - RDF + 1.0 t ha ⁻¹ VC + <i>Azospirillum</i> + PSB	0.59	0.11	0.39	21.37	4.00	14.07	0.72	0.26	0.68	25.94	9.52	24.67
T ₅ - 50 % RDF + 2.0 t ha ⁻¹ VC + <i>Azospirillum</i> + PSB	0.66	0.13	0.41	25.05	4.73	15.54	0.74	0.30	0.72	28.03	11.26	27.06
T ₆ - RDF + 2.0 t ha ⁻¹ VC + <i>Azospirillum</i> + PSB	0.69	0.15	0.43	27.35	5.87	17.08	0.79	0.32	0.75	31.38	12.63	29.61
T ₇ - 50 % RDF + 1.0 t ha ⁻¹ VC + <i>Azospirillum</i> + PSB + ZnSO ₄ 10.0 kg ha ⁻¹	0.75	0.16	0.44	30.48	6.53	18.08	0.81	0.33	0.77	32.93	13.29	31.05
T ₈ - RDF + 1.0 t ha ⁻¹ VC + <i>Azospirillum</i> + PSB + ZnSO ₄ 10.0 kg ha ⁻¹	0.76	0.17	0.46	31.20	7.21	18.69	0.82	0.34	0.79	33.57	13.82	32.35
T ₉ - 50 % RDF + 2.0 t ha ⁻¹ VC + <i>Azospirillum</i> + PSB + ZnSO ₄ 10.0 kg ha ⁻¹	0.77	0.18	0.47	32.05	7.56	19.62	0.83	0.35	0.80	34.47	14.34	32.84
T ₁₀ - RDF + 2.0 t ha ⁻¹ VC + <i>Azospirillum</i> + PSB + ZnSO ₄ 10.0 kg ha ⁻¹	0.78	0.20	0.48	33.75	8.72	20.72	0.85	0.36	0.81	36.70	15.67	34.97
S.Em ±	0.05	0.02	0.03	2.11	0.72	1.44	0.04	0.02	0.03	1.90	0.88	1.74
C.D (P= 0.05)	0.10	0.06	0.06	4.66	1.74	4.29	0.09	0.05	0.07	5.65	2.62	5.18

Table.2 Effect of INM on available nutrient (N, P₂O₅ and K₂O) as influenced by different treatments at harvest of safflower

Treatments	Available N (kg/ha)	Available P ₂ O ₅ (kg/ha)	Available K ₂ O (kg/ha)
T ₁	210.93	17.07	272.16
T ₂	203.47	12.64	266.32
T ₃	216.53	19.60	286.08
T ₄	214.67	18.33	278.16
T ₅	218.40	20.86	294.80
T ₆	220.27	21.49	302.24
T ₇	222.13	22.13	307.52
T ₈	224.00	23.39	310.24
T ₉	227.73	24.65	318.88
T ₁₀	229.60	25.29	320.42
S.Em±	3.96	1.75	6.48
C.D (P=0.05)	10.21	4.25	19.22

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