



## Effect of integrated nitrogen management on soil available nutrients, nutrient uptake and enzyme activity of soil at harvest of safflower (*Carthamus tinctorius* L.)

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### Abstract:

A field experiment was conducted during *rabi* 2009 - 10 on sandy loam soil at Student's Farm, College of Agriculture, Rajendranagar, Acharya N.G Ranga Agricultural University, Hyderabad, A.P, India to study the effect of organic manures in combination with inorganic nitrogen fertilizer on soil available nutrients status, nutrient uptake and enzymes ( urease and dehydrogenase) activity of soil after harvest of safflower (*Carthamus tinctorius* L.) The highest available nitrogen (212.19. a kg ha<sup>-1</sup>), P<sub>2</sub>O<sub>5</sub> (33.89 kg ha<sup>-1</sup>), K<sub>2</sub>O (433.07 kg ha<sup>-1</sup>), urease activity (6.97 µg of NH<sub>4</sub> + released g<sup>-1</sup>soil h<sup>-1</sup>) and dehydrogenase activity (12.29 mg of TPF produced g<sup>-1</sup>soil d<sup>-1</sup>) were recorded in the treatment receiving 50 % N through inorganic fertilizer + 50 % N through vermicompost. The highest N, P and K uptake was observed in the same treatment.

**Key words:** safflower, Urease activity and Dehydrogenase activity

### Introduction:

Safflower (*Carthamus tinctorius* L) is an ancient crop of india, cultivated during the winter season. It is grown for orange-red dye (carthamin) extracted from its brilliantly coloured florets and for much valued oil. Oil being rich in polyunsaturated fatty acid (linoleic 78%), plays an important role in reducing the blood cholesterol level. Crop cultivation under nutrient stress environment besides, poor crop managements are the major reasons for low productivity (623 kg ha<sup>-1</sup>) of the crop. India occupies the second place in safflower production in the world. Currently, it grows in an area of 2.29 lakh. ha. with a production of 1.42 lakh tonnes (2010-11). The general per hectare yields of safflower in india (642 kg ha<sup>-1</sup>) is low when compared to other leading

counties and world average (890 kg ha<sup>-1</sup>) (1). Significant efforts have been made to economise the use of fertilizers in field crops through application of biofertilizers and organic matter. Longterm fertilizer experiments shows that applications of fertilizers alone has a deleterious effect on soil health and crop productivity (2).

Integration of various sources of organic and inorganic fertilizers is more suitable because this reduces the application of chemical fertilizers and cost of cultivation, besides being an environmental friendly approach (3). Combined use of organic and inorganic sources of fertilizers increases the production and profitability of field crops and helps in maintaining the fertility status of soil.

### Material and methods:

A field experiment was conducted during *rabi* season, 2009-10 at student farm, College of Agriculture, Rajendranagar, Hyderabad in a randomized block design with eight treatments replicated thrice. The treatments consisted of 25 % and 50 % recommended dose of nitrogen fertilizer substituted by each of farm yard manure (FYM), poultry manure (PM) and vermicompost (VC) in combination with 50 % and 75 % N through inorganic fertilizer along with control (no N) and 100 N (100 per cent N through inorganic fertilizer).

The experimental site was sandy loam in texture having pH 7.12, EC 0.22 dSm<sup>-1</sup>, organic carbon 0.39 %, available N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O was 186, 28.8 and 408.5 kg ha<sup>-1</sup>, respectively. Safflower cultivar (NARI-6) was sown with the row spacing and plant spacing of 45 and 20 cm, respectively. Soil available

N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O were analyzed through alkaline permanganate method (4), Olsen's method (5) and flame photometer method (4), respectively. The uptake of N, P and K were analyzed by the standard procedure as described by (4). Activity of Urease was determined at harvest stage by using the procedure given by (6) and Dehydrogenase activity by (7).

Different organic sources such as VC, PM and FYM were used to supply N through different treatments in conjunction with inorganic N source following different proportions of organic manures with 1.20 % N, 0.20 % P<sub>2</sub>O<sub>5</sub> and 0.70 % K<sub>2</sub>O for VC, 1.46 % N, 0.83 % P<sub>2</sub>O<sub>5</sub> and 0.65 % K<sub>2</sub>O for PM, 0.50 % N, 0.20 % P<sub>2</sub>O<sub>5</sub> and 0.57 % K<sub>2</sub>O for FYM were applied 10 days before sowing accordingly as per the treatments. Recommended dose of fertilizers was N(40 kg ha<sup>-1</sup>) and P<sub>2</sub>O<sub>5</sub>(25 kg ha<sup>-1</sup>). Observations were recorded and the data was analyzed by using the procedure given by (8).

#### **Results and discussion:**

**Available Nutrients:** The available nitrogen in the soil was not significantly influenced by the type and level of manure in conjunction with inorganic fertilizer applied to safflower. The available nitrogen in soil was ranged from 169 to 212 kg ha<sup>-1</sup>. The available nitrogen in soil with 50 % N through inorganic fertilizer + 50 % N through vermicompost treatment was 25 % higher than that of control. The highest available nitrogen was recorded with 50 % N through inorganic fertilizers + 50 % N through vermicompost. This might be due to the direct addition of nitrogen through organic sources (FYM / PM/ VC) to the labile pool of soil.

The increasing available nitrogen content due to application of organic sources can also be attributed to the release of nutrients due to decomposition of organic matter by increased microbial activity and reduction in nitrogen loss by forming organo mineral complexes. Further, addition of mineral nitrogen along with organic sources will narrow down the C:N ratio of organic manures and this enhances the rate of mineralization and resulting in rapid release of nutrients. Among the treatments, 50 % N through inorganic fertilizer + 50 % N through vermicompost recorded the highest available phosphorus (33.89 kg ha<sup>-1</sup>). Significantly the lowest available phosphorus was recorded with control (24.96 kg ha<sup>-1</sup>) which has

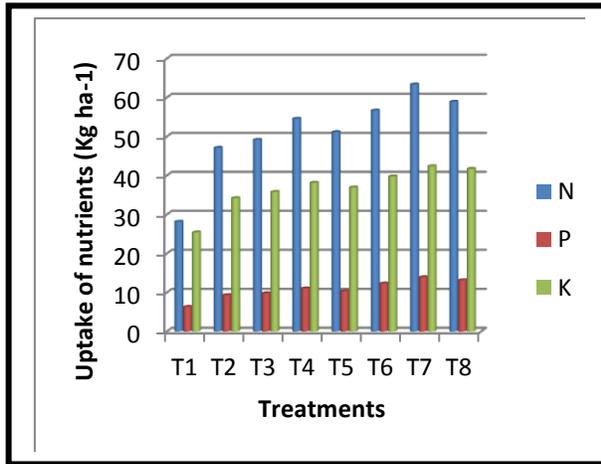
not received N fertilizer. This could be due to the production of organic acids during decomposition which might have solubilised the unavailable forms of P. The influence of organic anions on P availability can be ascribed to the phenomenon that the organic anions function as ligands which can increase occurrence of P in solution by replacing P sorbed at metal hydroxide surface through ligand exchange reactions or by dissolving metal oxides surfaces that sorb P or by complexing metals in solution and thus, preventing precipitation of metal phosphates.

Increasing available P might be due to the decomposition of organic matter accompanied by the release of appreciable quantities of CO<sub>2</sub>. The CO<sub>2</sub> released during decomposition of organic matter forms carbonic acid which solubilizes certain primary minerals too. Further, applied organic matter form a protective coating on sesquioxide and thus, reduces the phosphate fixing capacity of soil. These results confirm the findings of (9) and (10). The highest available potassium was recorded with 50 % N through inorganic fertilizer + 50 % N through vermicompost (433.07 kg ha<sup>-1</sup>). The available K<sub>2</sub>O contents due to 50 % N through inorganic fertilizer + 50 % N through vermicompost over control and 100 % nitrogen through inorganic fertilizer were increased by 14 and 11 per cent, respectively.

Increase in available K<sub>2</sub>O due to organic manures might be ascribed to the reduction of fixation and release of K due to interaction of organic matter with clay besides addition of K to the available pool. These results are inline with the findings of (9) and (10). The contents of available N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O due to application of different manures followed the order: vermicompost > poultry manure > farmyard manure.

Vermicompost showed superiority over poultry manure and farmyard manure even though it contained slightly lower contents of N and K than poultry manure. This indicated that though vermicompost application could not increase the total amount of nutrient in soil, it could make them more available.

**Fig 1: Uptake of nutrients at harvest by different treatments**



**Enzyme activity:** Urease activity (expressed as  $\mu\text{g}$  of  $\text{NH}_4^+$  released  $\text{g}^{-1}\text{soil h}^{-1}$ ) in soils for safflower ranged from 3.65 to 6.97. Among the treatments highest urease activity at harvest recorded with 50 % N through inorganic fertilizer + 50 % N through vermicompost ( $6.97 \mu\text{g}$  of  $\text{NH}_4^+\text{-N}$  released  $\text{g}^{-1}\text{soil h}^{-1}$ ). At harvest, among the treatments the plot which has received 50 % N through inorganic fertilizer + 50 % N through vermicompost recorded the highest dehydrogenase activity ( $12.29 \text{ mg}$  of TPF produced  $\text{g}^{-1}\text{soil d}^{-1}$ ). Highest activity of all the enzymes were associated with the application of 50 % N through inorganic fertilizers + 50 % N through vermicompost. The increased enzyme activity at harvest of safflower with increase in level of organic N application may be attributed to the increase in population of micro organisms like bacteria *etc.*. The lower activity of soil

**Table 1 : Effect of integrated nitrogen management on Soil available nutrients, Urease, Dehydrogenase, Dry**

Treatments	Soil available nutrients at harvest			Soil enzyme activity at harvest		Dry matter production at harvest	Seed yield ( $\text{kg ha}^{-1}$ )
	N	$\text{P}_2\text{O}_5$	$\text{K}_2\text{O}$	Urease ( $\mu\text{g}$ of $\text{NH}_4^+\text{-N}$ released $\text{g}^{-1}\text{soil h}^{-1}$ )	Dehydrogenase (mg of TPF produced $\text{g}^{-1}\text{soil d}^{-1}$ )		
T <sub>1</sub>	169.44	24.96	377.71	3.65	5.29	2076	610
T <sub>2</sub>	198.58	28.12	389.01	5.06	8.76	2551	1020
T <sub>3</sub>	201.81	29.39	408.16	5.27	9.26	2657	1059
T <sub>4</sub>	206.33	30.31	415.62	5.60	10.62	2815	1122
T <sub>5</sub>	204.03	29.79	410.50	5.43	9.78	2723	1077
T <sub>6</sub>	207.99	31.38	418.77	6.02	11.21	2898	1154
T <sub>7</sub>	212.19	33.89	433.07	6.97	12.29	3026	1239
T <sub>8</sub>	210.13	31.86	426.21	6.46	11.67	3016	1197
S.Ed±	<b>23.95</b>	<b>2.94</b>	<b>16.59</b>	<b>0.72</b>	<b>1.59</b>	<b>168</b>	<b>114</b>
CD (P=0.05)	NS	<b>6.31</b>	<b>35.59</b>	<b>1.54</b>	<b>3.41</b>	<b>361</b>	<b>245</b>

**matter and Seed yield of safflower at harvest**

enzymes with control as compared to combined treatments can be attributed to the lack of sufficient substrate *i.e.* organic carbon which acts as energy source for proliferating the microbial population. Thus, it is inferred that higher rates of N, P and K fertilization enhanced the activities of soil enzymes and the effect was more pronounced with organic manures in combination with fertilizers. Similar results were obtained by (10) for urease and (11) for dehydrogenase

in soil. The highest dry matter production was obtained with the application of 50% RDN through inorganic fertilizer + 50% N through vermicompost ( $1403 \text{ kg ha}^{-1}$ ). This increase in dry matter at flowering may be due to presence of several plant growth hormones like cytokinins and auxins in casts of earth worms which have positive beneficial effect on yield parameters (12). (13) reported that certain metabolites produced from earthworms may be responsible for stimulating

plant growth. The treatments applied with organic manures in combination with inorganic nitrogen fertilizer had significantly enhanced the dry matter production, this might be ascribed to the prevalence of better soil physical conditions and increased availability of nutrients which enhanced the uptake of nutrients, resulting in improved dry matter production. Similar results of increased dry matter were reported by (14) in sunflower.

**Effect of integrated nitrogen management on nutrient uptake:**

Highest total nitrogen uptake at harvest was recorded with the application of 50 % nitrogen through inorganic fertilizer + 50% N through vermicompost (63.36 kg ha<sup>-1</sup>) and the lowest nitrogen uptake at harvest was recorded with control which has not received nitrogen fertilizer. The vermicompost combinations with fertilizer nitrogen performed better than their corresponding combinations of FYM and poultry manure. It might be due to the steady and increased availability of nutrients from vermicompost, which might have resulted in increased uptake of nutrients by plants. The results were in accordance with the findings of (15) in green gram. The highest phosphorus and potassium uptake was also observed with the application of 50 % nitrogen through vermicompost and 50 % nitrogen through inorganic fertilizer. Higher uptake of phosphorus in vermicompost treated plots might be due to enhanced phosphatase activity, which contributed to increase in the availability of phosphorus. The variations in P and K uptake among different treatments might be attributed to their inherent capacity to supply nutrients for supporting crop growth. Similar results were reported by (16). At harvest the total uptake of potassium by plant recorded highest with 50 % nitrogen through vermicompost and 50 % nitrogen through inorganic fertilizer (42.40 kg ha<sup>-1</sup>). The results showed that manures in conjunction with inorganic fertilizers recorded significantly higher seed yield and stalk yield than control. The increase in seed yield due to 50 % N through inorganic fertilizer + 50 % N through vermicompost over control and 100 % nitrogen through inorganic fertilizer was 103 and 21 per cent respectively. This might be due to the immediate release of nitrogen through inorganic nitrogen and the latter by the mineralization of nitrogen through vermicompost resulting in steady supply of nutrients through out the crop growth period. These results were in accordance with findings of (17) in

maize –soybean cropping sequence. The beneficial effects of vermicompost in conjunction with inorganic nitrogen fertilizers on yield parameters have also been reported by (19) in safflower.

**Conclusion:**

From the above results, it can be inferred that integrated use of inorganic and organic sources of N will significantly increase available P and K status of the soil when compared with the application of N solely through chemical fertilizer. This can be ascribed to slow decomposition of organic manures which in turn increase the nutrient availability through enhanced microbial activities and release of nutrient from exchange sites. Among the treatments, the treatment received 50 % N through inorganic fertilizer + 50 % N through vermicompost recorded the highest seed yield, Drymatter, available nutrient (N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O), urease and dehydrogenase activity at harvest stage of crop growth compared to the corresponding combinations.

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