The Bioscan 11(3): 1653-1658, 2016 (Supplement on Agronomy)
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.com

RESPONSE OF SESAME (*SESAMUM INDICUM* L.) TO ORGANIC AND INORGANIC SOURCES OF NITROGEN IN LIGHT TEXTURED SOILS OF SEMI ARID BHAL REGION

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KEYWORDS
Nutrient management
Oil content
Sesame
Uptake

Received on :
16.02.2016

Accepted on :
28.07.2016

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ABSTRACT

Field experiment was conducted at Agriculture Research Station, Anand Agricultural University, Dhandhuka (Gujarat) during *kharif* seasons of 2003, 2005, 2006, 2007 and 2008 to study the "response of sesame (*Sesamum indicum* L.) to organic and inorganic sources of nitrogen in light medium textured soils of semi arid bhal region". The experiment was laid out in RBD with three replications. Application of 75 kg N ha^{-1} (100 % through inorganic source) exhibited the best results in pooled analysis in terms of seed yield (706 kg ha^{-1}), stover yield (1619 kg ha^{-1}), oil yield (380 kg ha^{-1}) net realization (Rs. 37,551) and benefit cost ratio (4.18). It can be summarized that the application of 75 kg N ha^{-1} (100 % inorganic sources) was found superior in sesame production and gave higher profit. However combined application of organic sources (FYM) and inorganic sources (urea) recorded significantly higher organic carbon and phosphorus in the soil after harvest of the sesame crop. The control plot recorded poor growth, lowest productivity and nutrient content. Among the farm yard manure exerted lesser effect on improving growth and productivity of the sesame crop but promoted greater effect on sustaining fertility status of the soil at higher level.

INTRODUCTION

The country has now been achieving self-sufficiency in cereal food production but vegetable oil is also necessary in suitable proportion as this has been proved to be indispensable for maintaining balanced human nutrition. The oil seed crop like sesame is also face the same problem in Gujarat because of its low productivity due to its cultivation in marginal land and no fertilizer is applied to the oilseed crops. This situation calls for a reorientation in our agricultural strategy to achieve a rapid breakthrough in the productivity of oil seeds specially sesame, on an enduring basis. In India, sesame occupies about 17.50 lakh hectares area with annual production of 6.13 lakh tones having an average productivity of 350 kg ha^{-1} (Anonymous, 2014). Sesame is cultivated on a large area in states of Maharashtra, Uttar Pradesh, Rajasthan, Orissa, Andhra Pradesh, Tamil Nadu, West Bengal, Gujarat and Karnataka. In Gujarat, it occupies an area of about 73,608 hectares with an annual production of 27,511 tones.

Nitrogen is the most important essential nutrient in plant nutrition. It is a constituent of a large number of necessary organic compounds such as amino acids, proteins, coenzymes, nucleic acids, ribosome's, chlorophyll, cytochrome and some vitamins Noorka *et al*. (2011). Several investigators reported the positive effects of applying nitrogen fertilization on growth, yield attributes, seed yield and quality of sesame. Fayed *et al*. (2000) detected that plant height, height of first capsule, number of capsules $plant^{-1}$, seed weight $plant^{-1}$ and seed yield ha^{-1} were increased by raising N fertilization from 71 to 142 Kg ha^{-1}. Also, Ashfaq *et al*. (2001) demonstrated that plant height, number of branches and capsules $plant^{-1}$, seed index and seed yield ha^{-1} were increased by increment N up to 120 Kg ha^{-1}. Malik *et al*. (2003) reported a significant increase in the number of capsules per plant (97.88) with the application of 80 kg N ha^{-1}. Haggai (2004) reported an increase in the number of pods from 18 to 44 with the application of 90 kg N ha^{-1} (from 0 kg N ha^{-1}). Papari Moghaddam Fard and Bahrani (2005) showed that the increase in N level up to 90 kg ha^{-1} significantly increased number of branch $plant^{-1}$ and seed yield of sesame. According to the results of the study of Bahrani and Babaei (2007) seed yield increased with N level where the highest seed yield was obtained at N level of 90 kg ha^{-1}. Haruna *et al*. (2010) found that application of 60 kg N ha^{-1} gave significantly better yields and economic returns.

Integrated approach by using both organic and inorganic nutrient sources seems to be a viable substitute method to obtain higher yields and economic advantages in sesame with standard quality oil further, integrated nutrient management system has become a recognized approach to evaluate the effect of different levels of organic and inorganic sources of nutrients in combination with bio-fertilizers on growth, yield and quality of sesame (Reddy *et al*., 2014). Higher yield of sesame can be obtained by integrated use of fertilizer along with FYM, Vermicompost and Azospirillium (purushottam, 2005 and Jaishankar and wahab, 2005). Maximum seed yield as well as net realization was recorded under application of N @ 25 kg ha^{-1} along with FYM 5 t ha^{-1} (Javia *et al*., 2010). Integrated nutrition *i.e*. 50% RDF + 5 t

FYM ha^{-1} expressed better growth and yield attributes with the highest seed yield, oil yield, net return, consumptive use, water use efficiency and nutrient uptake (Tripathy and Bastia, 2012). Integrated use of organic manure and chemical fertilizers in sesame helps maintaining stability in crop production, besides improving soil physical conditions (verma *et al.,* 2012). Integrated use of 50% RDF + 50% N through FYM or vermicompost + *Azospirillum* recorded 12.2, 20 and 15.6 % higher yield over 100 % RDF respec-tively (Ghose *et al*., 2013).

Combined application of available organic source along with optimal dose of inorganic fertilizers assures high and sustained productivity in an oil seed crop. Such information is lacking for nitrogen application combined with organic and inorganic sources in the sesame crop. The information on the use of organic manures like FYM and inorganic sources like urea for sesame crop is scanty. The present investigation was carried out to find out response of sesame to optimum combination of organic and inorganic sources of nitrogen in light medium textured soils of semi arid region.

MATERIALS AND METHODS

A field experiment was conducted during *kharif* seasons of 2003, 2005, 2006, 2007 and 2008 at Agriculture Research Station, AAU, Dhandhuka (Gujarat).The initial chemical analysis values of soil were 8.10 pH, 0.21 dS/m EC, 0.36 % low in organic carbon, low in available phosphorus (9.77 kg ha^{-1}) and high in available K_2O (325 kg ha^{-1}) at 0-15 cm soil depth and 8.10 pH, 0.24 dS/m EC, 0.35 % low in organic carbon, low in available phosphorus (10.25 kg ha^{-1}) and high in available K_2O (384 kg ha^{-1}) at 15-30 cm soil depth. The total rainfall received during the crop growth period was 787.6 mm in 2003, 858.2 mm in 2004, 1124.8 mm in 2005, 787.0 mm in 2006, 1172.5mm in 2007 and 884.0 mm in 2008. Experiment on sesame was laid out in randomized block design having three replications with thirteen treatments viz, 1) control, 2) 25 kg N ha^{-1} (25 % through FYM + 75 % through inorganic source), 3) 50 kg N ha^{-1} (25 % through FYM + 75 % through inorganic source), 4) 75 kg N ha^{-1} (25 % through FYM + 75 % through inorganic source), 5) 25 kg N ha^{-1} (50 % through FYM + 50 % through inorganic source), 6) 50 kg N ha^{-1} (50 % through FYM + 50 % through inorganic source), 7) 75 kg N ha^{-1} (50 % through FYM + 50 % through inorganic source), 8) 25 kg N ha^{-1} (75 % through FYM + 25 % through inorganic source), 9) 50 kg N ha^{-1} (75 % through FYM + 25 % through inorganic source), 10) 75 kg N ha^{-1} (75 % through FYM + 25 % through inorganic source), 11) 25 kg N ha^{-1} (100 % through inorganic sources), 12) 50 kg N ha^{-1} (100 % through inorganic sources) 13) 75 kg N ha^{-1} (100 % through inorganic sources). The organic manures and fertilizers were applied in the experimental plots before sowing as per the treatments. Small furrows were opened manually in each plot keeping the distance of 60 cm between the rows and fertilizers were applied uniformly in the furrows at the time of sowing as basal dose. The nitrogen was applied through urea (inorganic source) and FYM (organic source, it contains 0.5 % N, 0.2 % P_2O_5 and 0.5 % K_2O). Full dose of phosphorus in the form of diamonium phosphate were applied as basal. Treatment wise FYM were manually incorporated in soil before sowing of the crop as per the treatments. The net plot size for each treatment was 3.6 m × 5.0 m. The pure seeds of sesame variety Gujarat Till-2 were procured from Agricultural Research Station, Anand Agricultural University, Dhandhuka, District Ahmedabad and were used in the experiment. The common seed treatment was given with the fungicide Mancozeb @ 3 g kg^{-1} before sowing. Sowing was done manually in line in the previously opened furrows at 60 cm apart using the seed rate of 3.0 kg ha^{-1} on 24th June in 2003, 20th july in 2005, 18th july in 2006, 20th july in 2007 and 9th july in 2008. The seeds were covered with soil manually for better germination. Gap filling was done by reseeding of fresh treated seeds on seventh day after first seedling and thinning of additional seedling was done at 12 DAS to maintain a uniform intra-row plant population nearly at 10 cm apart. Manual hand weeding was done twice at 20 and 40 DAS. No irrigation was required to apply sesame crop. Crops were kept free from major insect pests and diseases. The observations on yield contributing characters were recorded. Seed oil content was analyzed by Nuclear Magnetic Resonance (NMR) technique suggested by Tiwari *et al*. (1974). The estimation of available P was done by using Olsen's extract (0.5 N sodium bicarbonates solution of pH 8.5) as suggested by Olsen *et al*. (1954) and determined as standard chloride reduced blue color. Organic carbon was determined by Walkley and Black (1934) wet digestion method and it is expressed in percentage. For data analysis proper and authentic results the standard method for RBD data analysis given by Cocharan and Cox (1967).

RESULTS AND DISCUSSION

Seed yield

The effect of different treatments on seed yield of sesame was significant during all the years as well as in pooled analysis except during 2003 (Table 1). The maximum seed yield was obtained under treatment 75 kg N ha^{-1} applied through inorganic fertilizer during all the years as well as in pooled analysis. This treatment was significantly superior over all the treatments, except 50 kg N ha^{-1} applied 100 % through inorganic fertilizer and 75 kg N ha^{-1} applied (75 % through FYM + 25 % through inorganic sources) during the year 2005. However, it remained at par with 50 and 75 kg N ha^{-1} (25 % through FYM + 75 % through inorganic sources), 75 kg N ha^{-1} (50 % through FYM + 50 % through inorganic sources), (75 % through FYM + 25 % through organic sources) and 25 and 50 kg N ha^{-1} (100 % through inorganic sources) during 2006. The same was at par with 50 kg N ha^{-1} (75 % through FYM + 25 % through inorganic sources), 25, 50 and 75 kg N ha^{-1} (25 % through FYM + 75 % through inorganic sources) during 2007 and 50 kg N ha^{-1} (100 % through inorganic sources) during 2007 and 50 kg N ha ha^{-1} (100 % through inorganic sources) during 2008 and in pooled analysis. Nitrogen is the structural component of protein molecules, amino acid, nucleic acid, nucleotides, enzymes, alkaloids, vitamins, chlorophyll. It is involved in photosynthesis respiration and protein synthesis. it imparts dark green colour to plants promotes leaf stem and other vegetative growth, produces rapid early growth and improves quality of the produces. When N supply is limited, leaf enlargement and thickness of branching inter node elongation; flowering and fruit setting

Table 1: Effect of different treatments on seed yield of sesame

Treat ments (Kg ha^{-1})	Sources	Yield (kg ha^{-1}) 2003	2005	2006	2007	2008	pooled
00	Control	731	430	357	346	529	480
25	25 % through FYM + 75 % through inorganic source	813	526	448	500	573	572
50	25 % through FYM + 75 % through inorganic source	827	602	482	526	667	621
75	25 % through FYM + 75 % through inorganic source	857	560	487	534	656	619
25	50 % through FYM + 50 % through inorganic source	739	581	409	406	693	585
50	50 % through FYM + 50 % through inorganic source	794	552	440	427	677	578
75	50 % through FYM + 50 % through inorganic source	880	573	482	448	628	602
25	75 % through FYM + 25 % through inorganic source	745	622	446	457	662	586
50	75 % through FYM + 25 % through inorganic source	787	596	448	451	646	586
75	75 % through FYM + 25 % through inorganic source	896	726	503	461	685	654
25	100 % through inorganic sources	824	492	451	443	635	569
50	100 % through inorganic sources	847	695	518	460	781	661
75	100 % through inorganic sources	866	771	526	537	828	706
S.Em		53.9	41.7	26.4	24.8	44.9	17.9
C.D. 0.05		NS	119.5	75.8	70.1	128.8	49.8
C.V. %		13.19	14.02	11.47	10.74	13.48	13.31

Table 2: Effect of different treatments on stover yield of sesame

Treat ments (Kg ha^{-1})	Sources	Yield (kg ha^{-1}) 2003	2005	2006	2007	2008	pooled
00	Control	2085	1654	729	612	895	1215
25	25 % through FYM + 75 % through inorganic source	2295	1771	745	878	1070	1352
50	25 % through FYM + 75 % through inorganic source	2480	1849	883	958	1229	1480
75	25 % through FYM + 75 % through inorganic source	2410	1959	917	935	1289	1501
25	50 % through FYM + 50 % through inorganic source	2225	1888	778	809	1255	1391
50	50 % through FYM + 50 % through inorganic source	2225	1992	839	768	1224	1410
75	50 % through FYM + 50 % through inorganic source	2341	2057	989	815	1294	1499
25	75 % through FYM + 25 % through inorganic source	2225	1953	828	760	1273	1408
50	75 % through FYM + 25 % through inorganic source	2387	2018	859	779	1300	1469
75	75 % through FYM + 25 % through inorganic source	2318	2044	958	815	1156	1458
25	100 % through inorganic sources	2318	2109	826	846	1184	1457
50	100 % through inorganic sources	2480	2148	859	940	1328	1551
75	100 % through inorganic sources	2480	2214	974	958	1469	1619
S.Em		71.0	36.5	54.7	46.9	73.4	26.1
C.D. 0.05		203.8	104.6	NS	134.6	210.7	72.7
C.V. %		6.10	8.70	12.7	11.22	11.89	8,05

Table 3: Effect of different treatments on oil content and oil yield of sesame in pooled analysis

Treatments(Kg ha^{-1})	Sources	Oil content(%)	Oil yield(kg ha^{-1})
00		45.79	242.9
25	25 % through FYM + 75 % through inorganic source	45.22	258.9
50	25 % through FYM + 75 % through inorganic source	45.67	303.8
75	25 % through FYM + 75 % through inorganic source	45.38	298.0
25	50 % through FYM + 50 % through inorganic source	45.53	314.8
50	50 % through FYM + 50 % through inorganic source	45.66	308.9
75	50 % through FYM + 50 % through inorganic source	45.88	288.4
25	75 % through FYM + 25 % through inorganic source	45.37	300.1
50	75 % through FYM + 25 % through inorganic source	45.56	294.5
75	75 % through FYM + 25 % through inorganic source	45.44	311.2
25	100 % through inorganic sources	45.75	290.6
50	100 % through inorganic sources	46.00	358.7
75	100 % through inorganic sources	45.84	379.5
S.Em		0.34	24.5
C.D. 0.05		NS	57.9
C.V. %		1.47	13.47

are adversely affected. Pathak *et al*. (2002) conducted a field experiment to evaluate the effect of N (0, 15, 30 and 45 kg ha^{-1}) on the growth and yield of sesame and pointed out application of 45 kg N ha^{-1} recorded the highest values of seed

Table 4: Effect of levels and different sources of nitrogen on soil organic carbon and available phosphorus after harvest of sesame in pooled analysis

Treat ments(Kg ha^{-1})	Sources	Organic carbon (%)		Phosphorus(Kg ha^{-1})	
		0-15cm	15-30cm	0-15 cm	15-30 cm
00	Control	0.315	0.305	7.3	08.5
25	25 % through FYM + 75 % through inorganic source	0.400	0.363	9.2	09.7
50	25 % through FYM + 75 % through inorganic source	0.390	0.378	15.6	14.9
75	25 % through FYM + 75 % through inorganic source	0.413	0.385	22.5	21.8
25	50 % through FYM + 50 % through inorganic source	0.403	0.388	14.2	15.8
50	50 % through FYM + 50 % through inorganic source	0.433	0.390	15.1	17.2
75	50 % through FYM + 50 % through inorganic source	0.410	0,410	22.5	23.5
25	75 % through FYM + 25 % through inorganic source	0.410	0.410	15.6	19.2
50	75 % through FYM + 25 % through inorganic source	0.428	0.428	17.1	21.0
75	75 % through FYM + 25 % through inorganic source	0.440	0.463	21.8	23.4
25	100 % through inorganic sources	0.348	0.348	15.1	16.6
50	100 % through inorganic sources	0.375	0,375	14.5	17.7
75	100 % through inorganic sources	0.386	0.380	18.4	19.2
S.Em		0,012	0.011	1.51	1.2
C.D. 0.05		0.035	0.032	3.40	3.4
C.V. %		6.15	5.90	18.90	13.64

yield (7.1 q ha^{-1}), net return (Rs. 4575 ha^{-1}) and benefit : cost ratio (1.81). Chaubey *et al*. (2003) in a field experiment with different levels of nitrogen (0, 15, 30, 45 and 60 kg ha^{-1}) reported that the growth, yield attributes and seed yield of sesame were significantly increased with increasing level of N application. Malik *et al*. (2003) found that among different N levels (0 40 and 80 kg ha^{-1}), N at 80 kg ha^{-1} produced the highest seed yield (79 t ha^{-1}), the highest 1000 seed weight (3.42g) and the highest seed oil content (45.88 %) of sesame. Okpara *et al*. (2007) conducted a field experiment to evaluate the effect of nitrogen on growth and yield of sesame and he pointed out that the application of nitrogen increase the yield of sesame. Shehu *et al*. (2010) the experiment comprised 4 nitrogen rates (0, 37.5, 75, 112.5 kg N per ha^{-1}) and they found that application of 75 kg N ha^{-1} gave highest number of capsule and seed yield. Haruna *et al*. (2010) conducted a field experiments and found that application of 60 kg N ha^{-1} gave significantly better yields and economic returns. Noorka *et al*. (2011) conducted a field experiments and found that Increasing N fertilizer level up to 205 Kg ha^{-1} significantly increased plant height, fruiting zone length, number of branches and capsules $plant^{-1}$, 1000-seed weight, seed weight $plant^{-1}$, seed oil content (%) and seed and oil yields ha^{-1}. Shilpi *et al*. (2012) conducted a field experiment and found that Plant height, number of branches $plant^{-1}$, seed yield, Stover yield were increased significantly with increasing N level up to 60 kg N ha^{-1}. Thakur *et al*. (2015) on the basis of two years experiment, he pointed out that application of nitrogen 45 kg ha^{-1} recorded significantly higher seed yield and test weight (7.13 q ha^{-1}, 7.81 q ha^{-1} and 3.57 g, 3.59 g) during 2012 and 2013 respectively, than the other N levels.

Stover yield

The effect of different treatments on stover yield of sesame was significant during all the years as well as in pooled analysis except during 2006 (Table 2). The maximum stover yield was obtained under treatment 75 kg N ha^{-1} applied (100 % through inorganic fertilizer) during all the years as well as in pooled analysis. The treatment was significantly superior over all treatments except 25 and 50 kg N ha^{-1} applied (100 % through inorganic fertilizer) as well as 50 and 75 kg N ha^{-1} (applied 75 % through FYM + 25 % through inorganic sources) and 25, 50 and 75 kg N ha^{-1} (applied 25 % through FYM + 75 % through inorganic source) during the year 2003. During 2005 and 2007 treatment 75 kg N ha^{-1} remained at par with 25 and 50 kg N ha^{-1} applied (100 % through inorganic fertilizer). However the same in 2007 was also remained at par with 25, 50 and 75 kg N ha^{-1} applied (25 % through FYM + 75 % through inorganic sources). During the year 2008 significantly higher stover yield was recorded under treatment 75 kg N ha^{-1} applied (100 % through inorganic fertilizer) was remained at par with 50 kg N ha^{-1} (applied 100 % through inorganic fertilizer) as well as 25 and 50 kg N ha^{-1} (applied 75 % through FYM + 25 % through inorganic sources), 75 kg N ha^{-1} (applied 50 % through FYM + 50 % through inorganic sources) and 75 kg N ha^{-1} (applied 25 % through FYM + 75 % through inorganic sources). In pooled results 75 kg N ha^{-1}applied (100 % through inorganic fertilizer) recorded significantly higher stover yield over all the treatments except 50 kg N ha^{-1}applied (100 % through inorganic fertilizer).

Oil content and oil yield

The effect of different treatments on oil content in seed of sesame was non significant (Table 3). However the significant produced oil due to application different treatment. The maximum oil yield was obtained under treatment 75 kg N ha^{-1}applied (100 % through inorganic fertilizer). This treatment was significantly superior over all the treatments except 50 kg N ha^{-1}applied (100 % through organic fertilizer).

Soil analysis

Soil analysis after harvest of sesame crop revealed that application of different treatment increased the soil organic carbon and available phosphorus significantly at the both depth i.e. 0-15 and 15-30 cm depth after harvest of sesame crop (Table 4).The treatment 75 kg N ha^{-1} (75 % through FYM + 25 % through inorganic source) recorded significantly higher organic carbon in the soil after harvest of the crop at 0-15 cm and 15-30 cm depth, but remained at par with treatments 75 kg N ha^{-1} (25 % through FYM + 75 % through inorganic source), 50 kg N ha^{-1} (50 % through FYM + 50 %

through inorganic source), 75 kg N ha^{-1} (50 % through FYM + 50 % through inorganic source), 25 kg N ha^{-1} (75 % through FYM + 25 % through inorganic source) on pooled basis (Table 4) at 0-15 cm soil depth. Addition of organic matter in to the soil through organic manures helped in modifies the soil reaction favorably to enhance the availability of organic carbon content and resulted in improvement of the soil fertility. Similar observations had also been reported by Jat and Ahlawat (2006), Akbari et *al*. (2010), Javia et *al*. (2010) and Munji et *al*. (2010) Nayek *et al*. (2014). Significantly higher available phosphorus content in the soil was recorded under treatment 75 kg N ha^{-1} (50 % through FYM + 50 % through inorganic source) than other treatments at 0-15 cm and 15-30 cm soil depth, but it was remained at par with treatment 75 kg N ha^{-1} (25 % through FYM + 75 % through inorganic source), 75 kg N ha^{-1} (75 % through FYM + 25 % through inorganic source) at 0-15 cm soil depth in pooled analysis (Table 4). Similar results were observed by Jat and Ahlawat (2006), Akbari *et al*. (2010), Javia *et al*. (2010), Munji *et al*. (2010), Tripathy and Bastia (2012) and Vijayakumari and Hiranmai (2012), Nayek *et al*. (2014).

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