EFFECT OF GRADED LEVELS OF MAJOR NUTRIENTS AND BIOFERTILIZERS ON YIELD, NUTRIENT CONTENT AND UPTAKE OF SAFFLOWER GROWING IN VERTISOL.

ABSTRACT

Effect of graded levels of major nutrients and biofertilizers on yield, nutrient content and nutrientuptake of safflower growing in *vertisols*was investigated in field experiment carried out on clayey soil at College of Agriculture, Nagpur during rabi seasonusing variety AKS/S-41 in 2011-12. The experiment was conducted in a Randomized Block Design (RBD) with three (3) replications and nine (9) treatments. N and P fertilizers each at 40 kg ha-1 were applied. The sources of Nand P were ureaand single super phosphate. The results of the study showed that yield, nutrientcontent and uptake N, P, K, parameters of safflower were significantly found highest in the treatment of RDF alone or in combination with Azospirillum + PSB. The seed and straw yield of safflower was also significantly highest in the same treatments. It is concluded that combination of biofertilizer and major fertilizers significantly improved the yield, nutrient content and uptake of safflower.

Key words: *Safflower, Biofertilizer, PSB, Grain, Straw,Yield.*

Introduction

Safflower (*Carthamustinctorius 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 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 contain 78 % linoleic acid whichis helps to prevent coronary disease) It also contains A, D, E and K vitamins. While the particularlinoleic acid in diet helps to prevent coronary disease (Paslawar*et al*., 2012) The safflower oil is also used to its dyeing properties; it is used in the manufacture of paints, varnishes, resins and linoleum.

In India it was cultivated over an area of 364 thousand hectares (50% world area) and had a production of 229 thousand tones (70%world production) during 2008-09 (Anonymous, 2009).Oilseed plays an important role in the rain-fed agro-ecosystem of Maharashtra. In Maharashtra, the total area and production of safflower was 256 thousand hectares and 101 thousand tones production with averageproductivity of 397kg ha^{-1}.The productivity of safflower is low and unstable due to vagaries of monsoon or uncertainties of response under moisture stress condition. Among the various factors that are responsible for grain production of crops, the nutrient management plays a significant role in deciding the crop yield. The high cost of chemical fertilizer, whereas continuous use leading to an imbalance nutrient in soil, thereby creating adverse effect on soil physicochemical properties.

Oilseeds productivity in the country is one of the lowest due to their cultivation under rain fed condition (>75% area) in marginal lands (Poor soil fertility) and by response of poor farmers (low investment, low input Use.) The recurring uncertainties in rainfall pattern, epidemics of insect pest and disease, uncertain price structure and escalating input cost make oilseeds cultivation risky for investment (Salih, M.N.T. 2013) Thus; safflower seeds production adequately depends on the rainfall situation with high degree of variation and sustainability.

Though oilseeds have higher requirement of nutrient they are grown under nutrient starvation/imbalance of even major nutrients, while their demand and response is high for secondary and micro-nutrients. Providing optimum crop growing conditions for sustainable and profitable oilseeds production is the priority with emphasis on improved the factor productivity and reducing the cost of production. Assessment of nutrient requirement of safflower and plants aids in efficient management of nutrient for sustainable safflower production.

There is a strong need of alternative source of nitrogen, especially bio fertilizer, in order to provide the nutrient supply through chemical fertilizer as well 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 solublising bacteria (PSB) solublise the unavailable phosphorus in soil to plant. Azotobacter andazospirillum are free-living bacteria that fix atmospheric nitrogen in cereal crops without any symbiosis and they do not need a specific host plant (Ingle *et al.,* 2001 andGuldekar*et al.,*2008)

Azotobacter abundant in well-drained, neutral soil. They can fix 15-20 $kgha^{-1}$ N per year (Guldekar*et al.*,2008)). Azotobacter can also produce antifungal compounds to fight against many plant pathogens (Jen-Hshuan Chen, 2006).

The proper supply of nutrients in balance amount is very essential for maximum production of safflower. Mineral fertilizers are costly and sometimes may be unavailable due to which its application in balance amount cannot be possible for most farmers. Almost all farmers are continuously use or relying on commercial fertilizers for maximum profitable yields, but there were nobuild-up of organic matter occurs in our soil. Mineral fertilizers when applied continuously over the years, affects the physical properties of the soil and may not havethe ability to produce more yields (Zia et al., 2000). Under such circumstance integration of mineral and organic fertilizers is very important, which plays a key role to sustain soil fertility and produce maximum yield. Kumar and Sharma (2004) reported that the use of organic nutrient sources with mineral nitrogen, phosphorus and potassium fertilizers were found more beneficial in terms of maximum yield and in providing macronutrients in safflower. Single source of nutrients such as mineral fertilizers, compost, animal manures and bio-fertilizers cannot meet the nutrient requirements of the crops for sustainable productionBhattacharya. (2004). therefore, a suitable ratio of organic and inorganic fertilizers is necessary for higher crop yield.

Since, the productivity of safflower in Maharashtra is quite low,i.e. productivity of 397kg ha^{-1}.Anonymous, (2009).there is need to study effect of nutrient levels to maximize productivity with minimum deterioration of soil. Keeping these considerations in view 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 Longitude at the elevation of 321.26 m above sea level.The soil of the experimental site was clayey in nature with pH 7.75 (1:2 soil: water) (Piper, 1996), low in EC 0.286dsm^{-1}(Piper, 1996), low in organic matter content of 0.5%

(Jackson, 1967), low in available N 174.25 kg ha^{-1} (Subbiah and Asija, 1956), medium in available P15.00kg ha^{-1}(Jackson, 1967) and medium in available K340kg ha^{-1}(Jackson, 1967) at the start of experiment. The experiment was laid out in a Randomized Block Design (RBD) with three replications having nine treatment combinations, that is, T_1 (control), T_2 (50% *RDF*), T_3 (50% *RDF* + *Azospirillum* + *PSB*), T_4 (100% RDF), T_5 (100% RDF + *Azosprillum* + *PSB*), T_6 (150% RDF), T_7 (150% RDF + *Azosprillum* + *PSB*),T_8 (50% RDF +2 % *DAP* spray at 30 and 45 DAS) and T_9(100% RDF +2 % *DAP* spray at 30 and 45 DAS). The fertilization N and P withbiofertilizer were applied at 40 : 40 kg ha^{-1}, respectively, whilecompost (FYM) was applied at 5 tons per 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, 1st dose at the time of sowing and 2nd at 30 DAS. Seed treatment done withAzospirillum and PSB @ 250g /10 kg of seed at the time of sowing. The germination was completed between 6th to 10th days after Sowing

Statistical analysis

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

RESULTSAND DISCUSSION

SafflowerYield is the most important goal for maximum return to farmer givenin Table 1. shows the data recorded on grain and straw yield as affected by biofertilizer and inorganic fertilizers. Grain and straw yield was significantly affected by the addition of biofertilizer and inorganic fertilizer. Among the treatments, maximum safflower grain and straw (27.78 q ha^{-1}) and strawyield (83.65 q ha^{-1}) was recorded by the treatment T_5 receiving 100% RDF + Azospirillum+ PSB which was followed by treatment T_7 with 150% RDF + Azospirillum+ PSB *i.e.* (27.78 and 75.36 q ha^{-1} grain and straw yield, respectively). Which were significantly superior over all treatments in straw yield. In grain yield treatment T_6 found to be at par with

treatment T_7. Whereas, lowest yield was obtained in control plot i.e. T_1 (17.25 and 45.38 q ha) grain and straw respectively, The better performance of Safflower crop in terms of yield was observed when bio fertilizer was combined with inorganic fertilizers. The better performance of the Safflower plants with biofertilizer and NPK fertilizers support the results of Ogundare*et al*. (2015), Adekiya and Agbede (2009) and Rajya*et al.* (2015) who reported that maximum nutrient availability due to integrated use of biofetilizer and inorganic fertilizers increased nutrient uptake by the plant which in turn lead to dry matter production and safflower yield. similarly the results closely confirmative bySingh and Singh (1980) and Rajput *et al.* (2007)

Nutrient Content of Nutrient in Safflower Grain and Straw

Table 2 shows the data regarding N,P,K uptake as affected by biofertilizer and inorganic fertilizers. The N,P,K uptake of safflower plant was significantly influenced by the integrated use of organic and inorganic nutrient sources. The highest P and K in safflower grain was observed in the treatments T_5 i.e. (100% RDF + Azospirillum+ PSB)i.e. N 2.59%, P 0.216% and K 1.65% followed by treatment T_7 i.e. (150% RDF + Azospirillum+ PSB) i.e. N 2.55% ,P 0.20% and K 1.63%. Treatment T_5 significantly superior over all treatments in N, P and K content of grain and T_8 found to be at par with treatment T_7 in N,P and K content of grain. The lowest content of N and P was found in control i.e. T_1 i.e. N 2.20% P 0.166% and K 1.56%.Similar results were closely reported by Ekshinge*et al.* (1995), Pisal and Shinde (1987) and Zaman and Das (1991).

From table 2, highest N, P and K content in safflower straw was observed in the treatments T_5 i.e. (100% RDF + Azospirillum+ PSB)i.e. N 0.58%, P 0.13% and K 1.57 % followed by treatment T_7.Treatement T_7 and T_8 found to be at par with each other in N and P content of safflower straw and treatment T_7, T_5, T_6 and T_8 found to be at par with each other in K content of safflower straw. The lowest NPK content in straw was observed in i.e. control T_1.

Nutrient Uptake of Safflower Grain and Straw

From the Table 3. Various treatments significantly influenced nutrient uptake in the present study.Increasing trend in uptake of NPK by safflower was observed with the increase in RDF levels and seed treatment with Azospirillum+ PSB. Highest uptake by safflower was recorded

with the (T_5) 100% RDF with seed treatment with Azospirillum+ PSB, followed by (T_7) 150 RDF with seed treatment with Azospirillum+ PSB of NPK. Treatment T_6 at par with treatment T_8 in N and P uptake of grain. Whereas K uptake in treatment T_8 found to be at par with treatment T_7. Whereas, treatment T_8 found to be at par with treatment T_7 in straw nitrogen uptake. Treatment T_6, T_7 and T_8 found to be at par with each other in phosphorus straw uptake whereas, the lowest uptake of NPK was found in the results were recorded by Pisal and Shinde (1987)

Total uptake of nutrients (kg ha^{-1}) by safflower crop

Inorganic fertilizers are concentrated forms of soil nutrients which can be transported much more readily than can bio fertilizer. Organic manures like FYM, compost released nutrients very slowly to the plants and these nutrients are judiciously absorb by the plants. Therefore, plants are unable access required amount of nutrients in the critical yield-forming period. This may be the probable reason for the higher yield produced by the inorganic fertilizer applied safflowerRajput *et al.* (2007). However,the present study increasing trend in uptake of NPK was observed with the increase in RDF level and seed treatment with (Azospirillum+ PSB). The highest uptake of nutrient by safflower was recorded with 100% RDF with seed treatment Azospirillum+ PSB, i.e. 112.07 N kg ha^{-1}, 17.02 P kg ha^{-1} and 171.16 K kg ha^{-1}, followed by 150% RDF with seed treatment Azospirillum+ PSB, i.e. 101.41 N kg ha^{-1}, 13.79 P kg ha^{-1} and 161.83 K kg ha^{-1}. T_5 was significantly superior in N,P and K uptake in over all treatment. The T_8 and T_6 found to be at par with treatment T_7 in P uptake of safflower crop.The Research has shown that combinations of biofertilizerand mineral fertilizers resulted in higher crop yields. (Mucheru-Muna*et al*., 2014; Mucheru-Muna*etal*., 2009; Mtambanengwe*et al.,* 2006; Nyamangara*et al.,* 2003).

Total uptake of nutrients increase might be due to the combined application of inorganic fertilizers and biofertilizers. Due to these treatments, nitrogen, phosphorous and potassium might have been gained by plants through RDF and biofertilizer. These results are in agreement with the finding of Papi Reddy *et al* (1994), Sagare*et al.* (1986) and Singh and Singh (1980) and lowest uptake of NPK was found in control plot i.e. 56.58 N kg ha^{-1}, 7.06 P kg ha^{-1} and 78.06 kg ha^{-1}

CONCLUSION

It may be concluded that application of 100% RDF and seed treatment of Azospirillum + PSB had profound effect on grain yield and NPK nutrientcontent and uptake by safflower as compared to application of inorganic fertilizers alone. Thus, application of fertilizer along with bio fertilizer can play a vital role in achieving high yield potential of safflower through its beneficial effect on nutrients supply and soil properties.

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Table 1: Yield of safflower (q ha^{-1}) as influenced by various treatments.

Treatments	Grain yield	Straw yield

T_1	Control	17.25	45.37
T_2	50% RDF	18.39	49.44
T_3	50% RDF + Azospirillum + PSB	21.05	59.87
T_4	100% RDF	21.80	71.02
T_5	100% RDF + Azospirillum+ PSB	27.78	83.65
T_6	150% RDF	23.40	80.16
T_7	150% RDF + Azospirillum+ PSB	24.55	75.36
T_8	50%RDF +2 % DAP spray at 30 and 45 DAS	17.58	58.01
T_9	100% RDF + 2% DAP spray at 30 and 45 days after sowing	18.22	53.15
	SE (m) ±	0.452	0.910
	CD at 5%	1.344	2.705

Table 2: Content of nutrients (%) in safflower grain and Straw.

Treatments		N		P		K	
		Grain	Straw	Grain	Straw	Grain	Straw
T_1	Control	2.20	0.43	0.166	0.10	1.56	1.18
T_2	50% RDF	2.32	0.45	0.170	0.11	1.59	1.46
T_3	50% RDF + Azospirillum + PSB	2.42	0.46	0.183	0.11	1.62	1.50

T_4	100% RDF	2.38	0.55	0.200	0.12	1.57	1.61
T_5	100% RDF + Azospirillum+ PSB	2.59	0.58	0.216	0.13	1.65	1.57
T_6	150% RDF	2.50	0.56	0.193	0.12	1.58	1.58
T_7	150% RDF + Azospirillum+ PSB	2.55	0.54	0.200	0.12	1.63	1.60
T_8	50%RDF +2 % DAP spray at 30 and 45 DAS	2.34	0.53	0.206	0.11	1.59	1.59
T_9	100% RDF + 2% DAP spray at 30 and 45 days after sowing	2.26	0.54	0.196	0.12	1.61	1.62
	SE (m) ±	0.0197	0.004	0.004	0.007	0.007	0.015
	CD at 5%	0.0587	0.014	0.012	0.022	0.023	0.046

Table 3: Uptake of nutrients (kg ha^{-1}) by safflower grain and straw.

Treatments		N			P			K		
		Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
T_1	Control	37.93	18.65	56.58	2.87	4.19	7.06	26.89	51.17	78.06
T_2	50% RDF	42.66	22.24	64.90	3.12	4.77	7.89	29.48	72.16	101.59
T_3	50% RDF + Azospirillum + PSB	50.92	27.73	75.32	3.86	7.18	11.04	34.15	89.80	123.95
T_4	100% RDF	51.79	38.54	90.34	4.36	9.23	13.29	34.21	114.34	146.49
T_5	100% RDF + Azospirillum+ PSB	63.56	48.51	112.07	5.32	11.71	17.02	39.84	131.33	171.16
T_6	150% RDF	58.50	44.89	103.39	4.52	9.61	14.14	37.05	126.65	163.70
T_7	150% RDF + Azospirillum+ PSB	60.72	40.69	101.41	4.76	9.04	13.79	39.00	122.83	161.83
T_8	50%RDF +2 % DAP spray at 30 and 45 DAS	41.14	30.74	71.68	3.63	6.38	10.00	27.95	92.23	120.63
T_9	100% RDF + 2% DAP spray at 30 and 45 days after sowing	41.21	28.70	69.91	3.58	6.37	9.95	29.32	85.96	115.28
	SE (m) ±	0.424	0.348	1.325	0.099	0.462	0.493	0.276	0.987	0.966
	CD at 5%	1.259	1.034	3.935	0.295	1.373	1.466	0.822	2.931	2.870