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Original Research Article

Response of *Kharif* Sunflower to Biofertilizers and Different Fertilizer Levels

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Sunflower, Fertilizer, Biofertilizer

A B S T R A C T

The field experiment was conducted during *kharif* season of 2016-2017 on vertisol soil at Oilseeds Research Station, Latur to study the "Response of biofertilizers on the performance of hybrid sunflower (*Helianthus annuus* L.) in *kharif* season". The experimental field was levelled and well drained. The soil was clayey in texture, low in available nitrogen (188.8 kg ha^{-1}), and medium in phosphorus (14.82 kg ha^{-1}) and rich in available potassium (588.72kg ha^{-1}). The soil was alkaline in reaction having soil pH (8.0). Result revealed that application of 100% N + *Azospirillum* + *Azotobacter* (T_9) recorded the highest seed yield (1848 kg ha^{-1}) with net monetary return (`34313) and B: C ratio (1.96).

Introduction

Sunflower (*Helianthus annuus L.*) is one of the fastest growing and important vegetable oilseed crops in the world, native to southern parts of USA and Mexico and ranks fourth next to groundnut, soybean and rapeseed. Sunflower (*Helianthus annuus* L.) is a temperate zone crop but it can perform well under varying climatic and soil conditions. In world it is cultivated on area of 18.12 million hectares with an annual production and productivity of 22.03 million tonnes and 1216 kg per hectare, respectively (Anon. 2014-2015). Sunflower (*Helianthus annuus* L.) is one of the most important oilseed crops in India, grown in an area of 0.55M ha with a production of 0.42 M.T. and productivity of 753 kg ha^{-1} respectively (Anon.2014-2015). In India soil fertility is diminishing gradually due to soil erosions, loss of nutrition, accumulation of toxic elements, water logging and unbalanced nutrient compensation. Organic manure and bio fertilizers are the alternate sources to meet the nutrient requirement of crops. Among biofertilizers, benefiting the crops are Azotobacter, Azosprillium, Phosphobacter and Rhizobacter are very important. Biofertilizer referred to living microorganisms, symbiotic and asymbiotic way of supplying nutrients to plants.

The asymbiotic nitrogen fixing bacteria Azotobacter, Azosprillium and Rhizobacter lead to significant improvement in crops yield by 15- 20%while reducing the depletion of soil nutrients. Efficiency of different biofertilizers Azospirillum, Azotobacter and Rhizobium with and without suboptimal levels of nitrogen (0, 15 and 75 kg/ha) and recommended level of N revealed that the application of 75 kg N/ha supplemented by Azospirillum (or) Azotobacter (or) Rhizobium was found to be more efficient in influencing the seed yield. It showed a significant increased in SSH-1 and the increased yield was statistically in KBSH-1 as compared to the application of recommended level of 100 Kg N alone/ha. Sunflower oil contains large amount of vitamins (A, D, E and K) and considerable amount of proteins (20 -40%). Biofertilizer can increase the soil fertility, the seed yield and its oil content (Dhanasekar and Dhandapani, 2012).

Biofertilizers plant resistant to adverse environmental stresses. The beneficial effect of Azotobacter is to fix the atmospheric nitrogen. It increases the seed germination, plant growth and yield. In certain condition they also exhibit antifungal activities and there by fungal disease may be controlled indirectly. Azospirillum also fix the atmospheric nitrogen and stimulates the effect on root development. It has ability to reduce nitrite and denitrify, also increase protein percentage.

Materials and Methods

The field experiment was conducted during 2016-2017 on vertisol at Oilseeds Research Station, Latur to study the “Response of biofertilizers on the performance of hybrid sunflower (*Helianthus annuus* L.) in *kharif* season”. The topography of experimental field was uniform and leveled. The soil was clayey in texture, low in available nitrogen (118.8 kg ha^{-1}), medium in phosphorus (14.82 kg ha^{-1}) and very high in available potassium (588.72 kg ha^{-1}) and alkaline in nature having soil pH 8.0. The adequate amount of rainfall during period of experiment was sufficient for significant for growth and development of sunflower crop which result in significantly higher yield. Overall the thermo-aero-hydro-dynamic properties during crop season were also favorable for physiological activities of crop and its phenophysic development. The experiment was laid out in a Randomized Block Design with nine treatments replicated thrice.

The treatments included T_1 (Control), T_2 (75% N), T_3 (100% N), T_4 (75% N + *Azospirillum* seed treatment), T_5 (75% N + *Azotobacter* seed treatment), T_6 (75% N + *Azospirillum* + *Azotobacter* seed treatment), T_7 (100% N + *Azospirillum* seed treatment), T_8 (100% N + *Azotobacter* seed treatment) and T_9 (100% N + *Azospirillum* + *Azotobacter* seed treatment). The gross and net plot size of each experimental unit was 5.4 x 4.5 m and 4.2 x 3.9 m respectively. Sowing was done on 23rd July, 2016 by dibbling the seeds at spacing 60 x 30 cm. The recommended cultural practices and plant protection measures were taken. As per treatments of bio-fertilizers and dose of nitrogen along with full dose of phosphorus and potassium was applied as a basal dose and remaining 50 per cent dose of nitrogen was applied at 30 days after sowing and crop was harvested at 23rd October, 2016.

Results and Discussion

Growth attributes

Plant height

The effect of different treatments on plant height was found to be significant and the higher plant height was recorded with the integrated application of treatment T9 (100% N + *Azospirillum* + *Azotobacter*) was found significantly superior than all other treatments. The significant treatment was found at par with treatment T_6 (75% N + *Azospirillum* + *Azotobacter*), T_8 (100% N + *Azotobacter*), T_7 (100% N + *Azospirillum*) and T_3 (100% N). The control treatment T_1 has lowest plants. The similar results were given by Mohsen Javahery *et al.*, (2011), Radwan, *et al.*, (2013), Tuba Mirparsa *et al.*, (2016).

Number of functional leaves

Data in respect of number of functional leaves plant^{-1} as influenced by different treatments at various growth stages. The application of treatment T_9 (100 % N + *Azospirillum* + *Azotobacter*) bears maximum number of functional leaves plant^{-1} at 60 DAS i.e.27.33. Which was at par with application of T_6 (75 % N + *Azospirillum* + *Azotobacter*) and T_8 (100% N + *Azotobacter),* and was found significantly superior over the rest of the treatments. It shows that the difference in number of functional leaves was real effect of applied treatments.

Stem girth (cm)

The effect of different treatments on stem girth was found to be significant and the higher stem girth was recorded with the treatment T_9 (100 % N+ *Azospirillum* + *Azotobacter*) was found significantly superior over all other treatments, except treatment T_6 (75 % N + *Azospirillum* + *Azotobacter)* were found at par with the significant treatment. The results are in line with M.M. Keshta *et al.*, (2006), Mohsen Javahery *et al.*, (2011), Amin Farnia *et al.*, (2015).

Leaf area (dm^2)

Data on mean leaf area per plant as influenced by different treatments are presented in Table 1. The treatments T_9 (100% N + *Azospirillum* + *Azotobacter*) was found maximum leaf area than any other treatment, except T_6 (75%N + *Azospirillum* + *Azotobacter*), T8 (100% N + *Azotobacter)* and T_7 (100% N + *Azospirillum*) which were at par with the significant treatment. The maximum leaf area was found at 60 DAS (50.67 dm^2).

The lowest leaf area due to less number of leaves was found for treatment T_1 (control). The results are coincides with Nandhagopal *et al.*, (2003), Rubapuntthavathy *et al.*, (2006),

Leaf area index

The data on leaf area index (LAI) as influenced by various treatments are presented in Table 1. The maximum leaf area index (2.81) was recorded at 60 DAS. For T_9 (100% N+ *Azospirillum* + *Azotobacter*).

The effect of treatment T_9 recorded higher LAI (2.81) for 60 DAS as compared to other treatments.

Yield attributes

The effect of different treatments was noticed on important yield attributes viz., number of filled seed plant $^{-1}$ (%), number of unfilled seed plant $^{-1}$, grain yield (g plant $^{-1}$) and test weight (g) was influenced dut to integrated application of organic and inorganic fertilizers.

Number of filled seeds plant^{-1}

The effect of nitrogen levels and *Azotobacter* and *Azospirillum* through different treatments on number of filled seeds per plant was significant. The mean numbers of filled seeds per plant were 671.

Table.1 Effect of biofertilizer and different fertilizer levels on growth attributes of sunflower

Treatments	Plant height (cm)	No. of functional leaves plant^{-1}	Stem girth (cm)	Leaf area (dm^2)	Leaf area index
T_1 – control	136.86	20.60	6.20	40.58	2.25
T_2 –75% Nitrogen	141.36	22.67	6.38	42.41	2.35
T_3 –100% Nitrogen	153.90	24.27	6.84	46.95	2.60
T_4 –75% N + Azospirillum	146.67	23.20	6.52	44.11	2.45
T_5 –75% N + Azotobacter	150.08	24.13	6.73	45.75	2.54
T_6 –75% N + Azospirillum + Azotobacter	166.92	26.53	7.75	48.97	2.72
T_7 –100% N + Azospirillum	157.94	24.80	7.01	47.64	2.64
T_8 – 100% N + Azotobacter	161.75	25.07	7.25	48.22	2.67
T_9–100%N+Azospirillum +Azotobacter	171.20	27.33	7.96	50.67	2.81
SE±	6.72	1.25	0.37	1.79	**2.55**
C.D.at 5%	20.16	3.75	1.11	5.37	2.25
General Mean	**154.08**	**24.29**	**6.96**	**46.14**	2.35

Table.2 Effect of Biofertilizer and Different fertilizer levels on yield attributes of sunflower

Treatments	Seed yield kg plant^{-1}	No. of filled seeds plant^{-1}	No. of unfilled seeds plant^{-1}	Seed yield plant^{-1} (g)	Test weight (g)
T_1 – control	705.33	441	166	23.94	45.47
T_2 –75% Nitrogen	1300.00	605	142	28.56	46.74
T_3 –100% Nitrogen	1383.87	665	129	29.55	47.26
T_4 –75% N + Azospirillum	1341.33	644	141	29.42	46.77
T_5 –75% N + Azotobacter	1343.00	654	134	28.76	47.05
T_6 –75% N + Azospirillum +Azotobacter	1784.67	774	102	38.47	49.05
T_7 –100% N + Azospirillum	1667.00	714	127	35.48	48.16
T_8 – 100% N + Azotobacter	1699.00	742	124	36.65	48.32
T_9–100%N+Azospirillum + Azotobacter	1848.00	802	99	38.81	49.72
SE±	60.14	33	5	1.77	2.19
C.D.at 5%	180.29	99	15	5.32	NS
General Mean	**1452.41**	**671**	**129**	**32.18**	**47.67**

Treatment T_9 (100% N + *Azospirillum* + *Azotobacter*) recorded maximum number of filled seed per plant (802) and it found significantly superior over treatments T_1 (Control), T_2 (75% N), T_3 (100%), T_4 (75% N + *Azospirillum*) and T_5 (75% N + *Azotobacter*) but it was at par with treatment T_6 (75% N + *Azospirillum* + *Azotobacter*), T_8 (100%N + *Azotobacter*) and T_7 (100% N + *Azospirillum*) treatment. The lowest number of filled seeds per plant was recorded for treatment T_1 i.e. (Control) followed by T_2 (75% N) seed treatments. The similar results were reported by Shehata *et al.*, (2003), Nandhagopal *et al.*, (2003), Pramanik *et al.*, (2013), Amin Farnia *et al.*, (2014)) and Sana Abdaslam *et al.*, (2016).

Unfilled seeds plant^{-1}

The data on number of unfilled seeds per plant are presented in Table 2. The mean number of unfilled seeds per plant were 129.The effect of nitrogen levels and bio-fertilizers (*Azotobacter*, *Azospirillum*) on number of unfilled seeds per plant was found to be significant treatment T_9 (100% N + *Azospirillum* + *Azolobacter*) recorded lowest number of unfilled seeds per plant (99), which was at par with treatment T_6 (75% N + *Azospirillum* + *Azotobacter*). The maximum number of unfilled seeds per plant was found for treatment T_1 (Control) which is 166 followed to by T_2 (75% N) seed treatment.

Seed yield plant^{-1}

The data on mean seed yield plant^{-1} (g) were presented in Table 2. The mean seed yield per plant was 32.18 g. The effect of nitrogen levels and bio-fertilizers through different treatment on seed yield plant^{-1} was significant. The treatment T_9 (100 % N + *Azospirillum* + *Azotobacter*) recorded maximum seed yield (38.81 g plant^{-1}) which was at par with T_6 (75%N + *Azospirillum* + *Azotobacter*), T_8 (100%N + *Azotobacter*) and T_7 (100% N + *Azospirillum*) treatment. The lowest seed yield per plant was recorded by treatment T_1 (23.94 g) followed by other treatments.

Test weight (g)

The data on test weight (1000 seed weight) as influenced by various treatments are presented in Table 2. The mean test weight of seed was 47.67 gm. An application of nitrogen levels and bio-fertilizers through different treatments influenced the test weight was not significantly. The treatment T_9 (100% N + *Azospirillum* + *Azotobacter*) recorded highest test weight (49.72 g) and the lowest test weight 45.47 (g) was recorded T_1.

Seed yield kg ha^{-1}

The data pertaining to seed yield are presented in Table 2 and graphically depicted in Fig. 5. The mean seed yield was 1452.41 kg ha^{-1}. Response of nitrogen levels *Azotobacter* and *Azospirillum* treatments on seed yield was significant.

The highest seed yield was for treatment T_9 (100% N + *Azospirillum* + *Azotobacter*) 1848 kg ha^{-1} which was significantly superior over treatment T_1 (Control), T_2 (75% N), T_3 (100% N), T_4 (75% N + *Azospirillum* treatment), T_5 (75% N + *Azotobacter*) and T_7 (100% N + *Azospirillum*) and at par with T_6 (75% N + *Azospirillum* + *Azotobacter*) and T_8 (100% N + *Azotobacter*). The lowest seed yield was observed for T_1 (705 kg ha^{-1}) control treatment. These findings are in confirmative with those reported by Keshta *et al.*, (2006), Madhurendra *et al.*, (2009), Rahim Naseri *et al.*, (2010), Dhanasekar *et al.*, (2012), Amin Farnia *et al.*, (2015), Khan *et al.*, (2016) and Tuba Mirparsa *et al.*, (2016).

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