Original Research Article

The Effect of Different Doses of Nitrogen and Seed Treatment with Biofertilizers on Growth, Yield and Seed Quality of Sunflower (Helianthus annusL.)

ABSTRACT

Aims: To study the effect of Different Doses of Nitrogen and Seed Treatment with Biofertilizers on Growth, Yield and Seed Quality of Sunflower.
Study design: The experiment was laid out in a randomized block design with eleven treatments replicated thrice.
Place and Duration of Study: The field experiment was conducted during rabi season of 2019-20, 2020-21, 2021-22 and 2022-2023 in the Instructional Farm of Ramkrishna Ashram Krishi Vigyan Kendra, Nimpith, South 24 Parganas, West Bengal.
Methodology: The experiment was carried out in randomized block design with eleven treatments and replicated thrice. The treatments were Control, 50% N, 100% N, Azospirillum (seed treatment), Azatobacter (seed treatment), Azospirillum +Azatobacter (seed treatment), 50% N + Azospirillum (seed treatment), 50% N + Azatobacter (seed treatment), 50% N +Azospirillum + Azatobacter (seed treatment), 75% N + Azospirillum + Azatobacter (seed treatment) and 100% N + Azospirillum + Azatobacter (seed treatment).A common dose of Nitrogen@ 90kg/ha, phosphorus @90kg/ha and potash @40kg/ha were applied.
Results: Higher head diameter (13.82 cm), 1000 seed weight (65.50 g), seed yield (1830 kg/ha), oil yield (628.80 kg/ha), gross return (Rs.48581), net return (Rs.26368) and B:C (2.19) than all other treatment followed by T10 (75% N + Azospirillum + Azotobacter) and T3 (100% N) which were statistically at par with each other.
Conclusion: On the basis of all parameter as well as economics it can be concluded that treatment T10 (75% N + Azospirillum + Azotobacter) can be recommended for better benefit and sustainable production of sunflower. The results of this experiment showed that use of chemical fertilizers can be reduced by using a combination of bio-fertilizers and inorganic nitrogen fertilizer.

Keywords:Sunflower, Biofertilizers, Seed treatment, Nitrogen, Oil percentage, Yield.

1. INTRODUCTION

Sunflower (Helianthus annus), commonly known as “Suryamukhi” belonging Asteraceae family, originated from Southern parts of USA and Mexico, is an important oilseed crop ranks fourth after groundnut, soybean and rapeseed in the world. It can show better performance under different climatic and soil condition though it is a temperate crop. It contains 45-50 % high quality edible oil which is rich in poly unsaturated fatty acid. It is cultivated in 18.12 m ha area with production and productivity of 22.03 mt and 1216 kg/ha respectively (Jonnagorla et al., 2021). In India, sunflower is grown in an area of 0.55 m ha with a production of 0.42 mt and productivity of 753 kg/ha. (Khandekar et al., 2018), most important oilseed crop which is very much responsible for meet up the lacking of oil production in India. Nitrogen is the very much essential plant nutrient responsible for growth and development of the crop, increases photosynthesis rate and leaf area resulted more net assimilation (Munir et al., 2007) ultimately improve the yield and seed quality (Ullah et al., 2010). Excessive use of nitrogen may decrease the microbial population of the soil leads to deteriorate soil health which attributed to

environmental hazards as well as health hazards and also may reduce the yield through increasing the plant lodging and decrease the seed quality as well as oil content in seed of sunflower (Scheiner et al., 2002). Therefore, Nitrogen fertilization should be judicious that improve the seed yield but could not hampered the human as well as soil health.

Biofertilizers include some useful microorganisms, which play an important role to increase the accessibility of essential nutrient to the plant that promoted the plant growth (Vessey, 2003) as well as promoting plant health (Han et al., 2007). Azotobacter and Azospirillum, inoculant biofertilizers which have direct and indirect effects on plant growth and pest resistance (Kennedy et al., 2004), free-living bacteria which add nitrogen from the atmosphere without any symbiosis and supply to cereals crop, are responsible for sustainable agriculture being a part of important component to integrated nutrient management (Akbari et al., 2011). Biofertilizer has specific beneficial role to increase the soil fertility as

Treatment.No.	Treatment Details	Plant Height (cm)	50% Flowering (Days)

sustainable way (Mekki and Ahmed, 2005) and plant growth & development that attributed to increase the seed yield and its oil content of sunflower (Dhanasekar and Dhandapani, 2012).

The present study was carried out to evaluate the performance of sunflower in respect to growth & development, yield attributes & yield by the effect of different doses of nitrogen and different methods of seed treatment with biofertilizers.

2. MATERIAL AND METHODS

The field experiment was conducted during rabi season of 2019-20, 2020-21, 2021-22 at Instructional Farm of Ramkrishna Ashram Krishi Vigyan Kendra, Nimpith, South 24 Parganas, West Bengal to evaluate the effect of different doses of nitrogen and different methods of seed treatment with biofertilizers on growth & development, yield attributes and yield of Sunflower. The experiment field was levelled and uniform. The soil was clayey in texture, low in available nitrogen (233.36 kg ha-1), low in phosphorus (21.94 kg ha-1) and medium in available potassium (252.43 kg ha-1), low in organic carbon (0.52) and neutral in nature having soil pH 6.75. The each and every gross plot size was 5.4 m × 4.8 m and net plot size 4.8 m × 4.5 m, spacing was 60 cm × 30 cm. The experiment was carried out in randomized block design with eleven treatments and replicated thrice. The treatments were T1=Control, T2=50% N, T3=100% N, T4=Azospirillum (seed treatment), T5=Azotobacter (seed treatment), T6=Azospirillum + Azatobacter (seed treatment), T7=50% N + Azospirillum (seed treatment), T8=50% N + Azatobacter (seed treatment), T9=50% N + Azospirillum + Azatobacter (seed treatment), T10=75% N + Azospirillum + Azatobacter (seed treatment) and T11=100% N + Azospirillum + Azatobacter (seed treatment). A common dose of Nitrogen@90kg/ha, phosphorus @90kg/ha and potash @40kg/ha were applied. Full phosphate and potash were applied as basal. Nitrogen and biofertilizer were applied as per treatment. Crop was irrigated in three times during vegetative growth, flowering and achene development stage. General cultural practices and plant protection measures were taken as per recommendation. Sunflower variety KBSH-53 was used for this experiment.

Growth parameters viz. plant height (cm), 50% Flowering, head diameter (cm) was recorded from five randomly selected plants of each plot separately as well as yield and yield attributing character Viz. test weight (g), seed yield (kg/ha), oil content (%) and oil yield (kg/ha) were recorded as per the standard method.

Economic parameters like total cost of cultivation, gross return, net returns, benefit-cost ratio were worked out on the basis of prevailing market prices of inputs and outputs for all of the season. All the biometric data recoded on various parameters from the experimental crop were assembled in appropriate tables and analyzed statistically by the analysis of variance method (Gomez and Gomez, 1984) as adopted for the procedure recommended for randomized block design. The significance of different sources of variation was tested by Fisher and Snedecor's 'F' test at probability level of 0.05.

3. RESULTS AND DISCUSSION

Plant Height:

Effect of different nitrogen fertilizer levels and bio-fertilizer on plant height was tabulated in table 1 and the table revealed that higher plant height (148 cm, 141 cm, 139 cm, 135 cm and 141 cm in the year of 2019-20, 2020-21, 2021-22, 2022-23 and pooled data respectively) was recorded from the treatment T11 (100% N + Azospirillum + Azotobacter) which was significantly higher than the other treatment (Pooled data). It might be due to the continuous application of chemical nutrients throughout the whole growing period with biofertilizers (azospirillum and azotobacter). Due to use of biofertilizers, nutrient losses through leaching may be reduced because of biofertilizers having mobilizing ability of nutrients from non-usable form to usable forms (Jonnagorla et al., 2021) and increase the accessibility of essential nutrient to the plant that promoted the plant growth (Vessey, 2003) which attributed to increase the plant height. The similar results were reported by Khandekar et al., (2018);Jonnagorla et al., (2021); Javahery and Rokhzadi (2011); Radwan et al., (2013) and Mirparsa et al., (2016).

Table 1. Effect of different nitrogen fertilizer levels and bio-fertilizer on growth attributes of sunflower

		2019-20	2020-21	2021-22	2022-23	Pooled	2019-20	2020-21	2021-22	2022-23	Pooled
T_1	Control (No Nitrogen)	105	93	102	103	101	64	70	66	57	64
T_2	50% N	128	116	115	118	119	65	71	69	60	66
T_3	100% N	142	126	122	121	128	67	75	72	64	70
T_4	Azospirillum (seed treatment)	106	95	105	106	103	64	70	68	59	65
T_5	Azotobacter (seed treatment)	115	101	107	107	108	64	70	68	60	66
T_6	Azospirillum + Azotobacter (Seed treatment)	127	112	110	114	116	64	77	69	62	68
T_7	50% N + Azospirillum	129	116	117	117	120	65	76	70	60	67
T_8	50% N + Azotobacter	132	120	121	120	123	66	77	71	61	67
T_9	50% N + Azospirillum + Azotobacter	135	122	125	123	126	66	73	72	64	69
T_{10}	75% N + Azospirillum + Azotobacter	140	130	132	129	133	67	75	72	64	70
T_{11}	100% N + Azospirillum + Azotobacter	148	141	139	135	141	67	76	73	67	71
SEm (±)		**2.02**	**1.89**	**1.80**	**1.78**	**1.60**	**0.36**	**0.47**	**0.49**	**0.60**	**0.48**
CD at (5%)		**5.92**	**5.48**	**5.27**	**5.24**	**4.69**	**NS**	**1.38**	**1.42**	**1.76**	**1.40**

Treatment. No.	Treatment Details	Seed Yield (kg/ha)				
		2019-20	2020-21	2021-22	2022-23	Pooled
T_1	Control (No Nitrogen)	1026	899	707	768	868
T_2	50% N	1221	1295	1181	1451	1287
T_3	100% N	1688	1711	1692	1620	1678
T_4	Azospirillum (seed treatment)	1245	854	836	869	951
T_5	Azotobacter (seed treatment)	1281	868	870	858	969

50% Flowering:

From the pooled data it was observed that treatments were varied with respect 50% flowering from 64 days to 71 days. It was clearly found that sunflower plant took more time to emerge 50% flowering with increasing dose of nitrogenous fertilizer. Treatment T11 (100% N + Azospirillum + Azotobacter) registered the significantly more time to emerge 50% flowering which was statistically at par with Treatment T10 (75% N + Azospirillum + Azotobacter) and T3 (100% N). No significant differences had been found among the biofertilizer treatment with respect to 50% flowering.

Table 2. Effect of different nitrogen fertilizer levels and bio-fertilizer on Yield attributes of sunflower

Head Diameter:

Higher head diameter of sunflower (15.30 cm, 13.91cm, 13.50 cm, 12.56 cm and 13.82 cm in 2019-20, 2020-21,2021-22 and 2022-23 respectively) was registered in the treatment T11(100% N + Azospirillum + Azotobacter) followed by T10 (75% N + Azospirillum + Azotobacter) and T3 (100% N) which were statistically at par with each other. Pooled data recorded the same trend. Head diameter increased might be due to adequate supply of nitrogen which leads to more photosynthetic activities by encouraging cell elongation, cell division which enhance the number of metabolites necessary for building plant organs (Wajid et al., 2012). Head diameter of sunflower is increased significantly with increasing dose of mineral nitrogen with biofertilizer opined byMohamed (2003).

Treatment.No.	Treatment Details	Head Diameter (cm)					1000 Seed weight (g)				
		2019-20	2020-21	2021-22	2022-23	Pooled	2019-20	2020-21	2021-22	2022-23	Pooled
T_1	Control (No Nitrogen)	10.82	8.59	9.80	9.20	9.60	52.00	45.00	49.00	42.00	47.00
T_2	50% N	13.82	11.08	12.20	11.63	12.18	61.00	58.00	58.00	50.00	56.75
T_3	100% N	16.34	12.30	13.40	12.56	13.65	64.00	61.00	62.00	58.00	61.25
T_4	Azospirillum (seed treatment)	11.78	8.40	9.90	9.40	9.87	57.00	48.00	51.00	44.00	50.00
T_5	Azotobacter (seed treatment)	12.73	8.59	10.20	9.80	10.33	58.00	50.00	52.00	45.00	51.25
T_6	Azospirillum + Azotobacter (Seed treatment)	13.06	8.82	10.80	10.20	10.72	59.00	53.00	54.00	48.00	53.50
T_7	50% N + Azospirillum	13.58	10.08	10.90	11.14	11.43	61.00	55.00	56.00	50.00	55.50
T_8	50% N + Azotobacter	14.74	10.87	11.00	11.16	11.94	62.00	56.00	58.00	52.00	57.00
T_9	50% N + Azospirillum + Azotobacter	15.70	11.40	12.30	11.36	12.69	64.00	58.00	60.00	55.00	59.25
T_{10}	75% N + Azospirillum + Azotobacter	16.10	12.18	12.75	12.03	13.27	68.00	62.00	61.00	63.00	63.50
T_{11}	100% N + Azospirillum + Azotobacter	15.30	13.91	13.50	12.56	13.82	71.00	64.00	63.00	64.00	65.50
SEm (±)		**0.36**	**0.36**	**0.24**	**0.22**	**0.27**	**0.68**	**0.68**	**0.52**	**0.83**	**0.81**
CD at (5%)		**1.04**	**1.06**	**0.70**	**0.65**	**0.78**	**1.99**	**2.01**	**1.53**	**2.45**	**2.40**

Table 3. Effect of different nitrogen fertilizer levels and biofertilizer on Yield of sunflower

T_6	Azospirillum + Azotobacter (seed treatment)	1247	870	855	900	968
T_7	50% N + Azospirillum	1291	1636	1192	1272	1348
T_8	50% N + Azotobacter	1314	1850	1240	1279	1421
T_9	50% N + Azospirillum + Azotobacter	1349	1925	1251	1375	1475
T_{10}	75% N + Azospirillum + Azotobacter	1552	2165	1363	1512	1648
T_{11}	100% N + Azospirillum + Azotobacter	1746	2211	1728	1634	1830
SEm (±)		**68.94**	**125.50**	**92.23**	**83.56**	**94.08**
CD at (5%)		**203.38**	**370.27**	**272.09**	**246.50**	**271.73**

Table 4. Effect of different nitrogen fertilizer levels and biofertilizer on Oil yield and oil percentage of sunflower

Treatment.No.	**Treatment Details**	**Oil Yield (Kg/ha)**					**Oil (%)**				
		2019-20	**2020-21**	**2021-22**	**2022-23**	**Pooled**	**2019-20**	**2020-21**	**2021-22**	**2022-23**	**Pooled**
T_1	Control (No Nitrogen)	362.18	319.15	275.99	270.03	306.84	35.30	35.50	35.52	35.16	35.37
T_2	50% N	420.63	447.42	404.85	498.42	442.83	34.45	34.55	34.28	34.35	34.41
T_3	100% N	564.80	580.54	577.99	554.53	569.47	33.46	33.93	34.16	34.23	33.95
T_4	Azospirillum (seed treatment)	402.63	314.44	309.99	311.28	334.59	32.34	36.82	37.08	35.82	35.52
T_5	Azotobacter (seed treatment)	435.54	312.22	318.68	314.03	345.12	34.00	35.97	36.63	36.6	35.80
T_6	Azospirillum + Azotobacter (seed treatment)	415.13	326.51	321.82	346.77	352.56	33.29	37.53	37.64	38.53	36.75
T_7	50% N + Azospirillum	444.10	560.00	411.72	439.22	463.76	34.40	34.23	34.54	34.53	34.43
T_8	50% N + Azotobacter	465.81	621.05	427.68	448.55	490.77	35.45	33.57	34.49	35.07	34.65
T_9	50% N +Azospirillum + Azotobacter	523.74	647.96	440.35	477.95	522.50	35.75	33.66	35.2	34.76	34.84
T_{10}	75% N + Azospirillum + Azotobacter	547.08	729.82	470.64	524.82	568.09	35.25	33.71	34.53	34.71	34.55
T_{11}	100% N + Azospirillum + Azotobacter	603.24	741.35	598.23	572.39	628.80	34.55	33.53	34.62	35.03	34.43
SEm (±)		**16.33**	**28.61**	**21.83**	**20.47**	**22.55**	**0.23**	**0.27**	**0.23**	**0.29**	**0.55**
CD at (5%)		**48.29**	**84.44**	**64.49**	**60.45**	**79.60**	**0.68**	**0.79**	**0.69**	**0.85**	**1.58**

1000 Seed weight (g):
The data on 1000 seed weight as influenced by different treatments are summarized in Table 2. From the pooled data it was observed that the treatment T11 (100% N + Azospirillum +Azotobacter) recorded the highest 1000 seed weight (65.50 g) which was significantly higher than the all-other treatment except T10 (75% N + Azospirillum + Azotobacter) treatment. The treatment T10 (75% N + Azospirillum + Azotobacter) was at par with T11 (100% N + Azospirillum + Azotobacter) and T3(100% N) with respect to 1000 seed weight. Lowest 1000 seed weight was achieved in control plot. 1000 seed weight was increasedfor sunflower might be due to inorganic nitrogen application with Bio-fertilizers as a source of N2 fixing bacteria reported by Keshta and Kholy (1999) which leads to more availability of readily available form of nitrogen that promote better growth & development of the crop and more photosynthates attributed to more translocation occurred in sunflower seed that increased the 1000 seed weight. Similar type of result had been reported by Khandekar et al., (2018).

Seed Yield (kg/ha):
Data related to seed yield (Kg/ha) was presented in table 3. From the pooled data it was clearly observed that highest seed yield (1830 kg/ha) was obtained from the treatment T11 (100% N + Azospirillum + Azotobacter) followed by T3 (1678 kg/ha) and T10 (1648 kg/ha) which were statically at par with each other. Control plot recorded the lowest seed yield (868 kg/ha). The seed yield was increased might due to the application of the combined use of inorganic fertilizers and bio fertilizers which enhanced the availability of essential nutrients with respect to both macro- and micronutrients (Jayabal and Chelliah, 2000) and also biofertilizers such as azotobacter and azospirillum released the growth promoting

Treatment.No.	Treatment Details	Economics (Pooled Data)

substances and proliferated the beneficial micro-organism which improve the physical properties of the soil resulting better root development leads to higher nutrient uptake by the crop and increase in seed yield (Jonnagorla et al., 2021). These findings are confirmed by several researchers such as Tuba Mirparsa et al., (2016), Khan et al., (2016), Farnia and Mehrdad (2015) and (Dhanasekar and Dhandapani, 2012).

Oil Percentage (%):
From the data of oil percentage in seed of sunflower, it was found that oil percentage gradually decreased with increased dose of nitrogenous fertilizer.Oil percentage in Sunflower oil responded negatively due to application of higher nitrogen affected fatty acid composition in sunflower oil reported by Steer & Seilor (1990) and Khaliq (2004). Greater nitrogen supply increased the amount of seed oil per plant but reduced seed oil concentration (Steer et al., 1984). No significant differences had been found with respect to oil percentage among the treatment with different nitrogen doses and bio-fertilizer. Highest oil percentage (36.75%) was recorded by the treatment T6 (Azospirillum + Azotobacter) followed by T5 (35.80%), T4 (35.52%) and T1 (35.37%) i.e. control plot which were statistically at par with each other.

Oil Yield (kg/ha):
Table 4 presented the effect of different nitrogen doses and bio-fertilizers on oil yield of sunflower. From the pooled data, it was observed that treatment T11 (100% N + Azospirillum + Azotobacter) achieved highest oil yield (628kg/ha) among the other treatment followed by T3 (569.47 kg/ha) and T10 (568 kg/ha) which were statically at par with T11. Oil yield of sunflower is increased because of bio-fertilizers promoted plant growth by increasing the availability of essential nutrients to the plants that increased the seed yield which attributed to increased oil yield & oil content of sunflower. This explanation was confirmed or agreed by Vessey (2003).

Table 5. Effect of different nitrogen fertilizer levels and bio-fertilizer on Economics of Sunflower

		Cost of Cultivation (Rs.)	Gross return (Rs.)	Net Return (Rs.)	B:C
T_1	Control (No Nitrogen)	20675	22720	2045	1.10
T_2	50% N	21434	34664	13231	1.62
T_3	100% N	22173	44784	22611	2.02
T_4	Azospirillum (seed treatment)	21130	24785	3655	1.17
T_5	Azotobacter (seed treatment)	21183	25219	4037	1.19
T_6	Azospirillum + Azotobacter (seed treatment)	21150	25285	4135	1.20
T_7	50% N + Azospirillum	21556	35796	14240	1.66
T_8	50% N + Azotobacter	21556	37665	16109	1.75
T_9	50% N + Azospirillum + Azotobacter	21469	39159	17690	1.82
T_{10}	75% N + Azospirillum + Azotobacter	21838	43610	21772	2.00
T_{11}	100% N + Azospirillum + Azotobacter	22213	48581	26368	2.19
SEm (±)		-	**1723**	**902**	**0.07**
CD at (5%)		-	**5083**	**2627**	**0.21**

Economics:

Data related to economics tabulated in table 5 and the table revealed that significantly highest gross return (Rs.48581), net return (Rs. 26368)and B:C (2.19) was documented in the treatment T11 (100% N + Azospirillum + Azotobacter) among the all-other treatment followed by T3 (Rs.44784, Rs. 22611 and 2.02 in gross return, net return and B:C respectively) and T10 (Rs.43610, Rs. 21772 and 2.00 in gross return, net return and B:C respectively) which were non-significantly varied with T11. Control plot recorded the lowest gross return, net return and B: C.

4. CONCLUSION

Treatment T11 (100% N + Azospirillum + Azotobacter) recorded the higher head diameter (13.82 cm), 1000 seed weight (65.50 g), seed yield (1830 kg/ha), oil yield (628.80 kg/ha), gross return (Rs.48581), net return (Rs.26368) and B:C (2.19) than all other treatment followed by T10 (75% N + Azospirillum + Azotobacter) and T3 (100% N) which were statistically at par with each other. On the basis of all parameter as well as economics it can be concluded that treatment T10 (75% N + Azospirillum + Azotobacter) can be recommended for better benefit and sustainable production of sunflower. The results of this experiment showed that use of chemical fertilizers can be reduced by using a combination of bio-fertilizers and inorganic nitrogen fertilizer.

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