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Effect of seed rates and fertilizer levels on growth and yield of linseed (*Linum usitatissimum* L.) under climatic conditions of Punjab

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Abstract

Experiment was conducted during rabi *season of 2019-20 at the Agricultural Research Farm Dhablan of the G.S.S.D.G.S. Khalsa college Patiala, Punjab. The field experiment was laid out in spilt plot design with 12 different treatments with 3 replications, combination of spacing and feltilizer levels. The soil of experimental field was clay in texture with pH 8.7 and contained organic carbon 0.36%, available nitrogen 262 kg ha^{-1}, available phosphorus 22.60 kg ha^{-1} and available K 129 kg ha^{-1}. All nutrients were applied in basal dose at one day before sowing. The treatment F_3 (N:P:K:S @ 60:30:30:30 kg ha^{-1}) recorded significantly maximum plant height, number of branches per plant, dry weight of plant at all the stages of observations 30, 60, 90 DAS and at harvest stages. The treatment F_2 (N:P:K:S @ 40:20:20:20 kg ha^{-1}) had statically at par with treatment F_3 (N:P:K:S @ 60:30:30:30 kg ha^{-1}) at 30DAS.Application of different levels of seed rate had significant effect on plant height at all the stages expect at 30 DAS. However, at 30, 60, 90 DAS and at harvest treatment S_3 (50 kg ha^{-1} seed rate) recorded significantly higher plant height, number of branches per plant, dry weight of plant as compared to S_2 (40 kg ha^{-1} seed rate) and S_1 (30 kg ha^{-1} seed rate). Treatment S_2 (40 kg ha^{-1} seed rate) recorded at par with S_3 (50 kg ha^{-1} seed rate) at 30DAS. The significantly higher seed yield (14.81 q ha^{-1}) was recorded in treatment S_2 (40 kg ha^{-1} seed rate) as compared to treatment S_1 (30 kg ha^{-1} seed rate) and treatment S_3 (50kg ha^{-1} seed rate).*

Key word: Linseed, Spacing, Capsule

Introduction

Linseed (*Linum usitatissimum* L.) also known as flaxseed. Linseed belongs to family Lineaceae, it is annual herb and the plant height is 30-120 cm. Linseed is an important oil seed and fibre crop. Seed is also known as Alsi. The important characteristics of linseed crop are survival and cultivation in wide range of sub-tropical, tropical and temperate zone because it bears the biotic and abiotic stresses. Oil of linseed is also useful for human consumption because linseed is rich in omega-3 fatty acid, especially alpha-linolenic acid. It also contains chemicals like lignans, which helps to prevention of cancer (Delesa and Choferie 2015).

The linseed cake was also very rich in protein, fibre and total humidity. So, it is very beneficial for health of Cattles. The linseed oil cake also used as manure because it contains 5% nitrogen, 1.4% phosphorus and 1.8% potassium. (Anonymous 2020). It provides protection from soil nematodes and insects. It also improves yields and quality of produce like taste, flavour and amino acid composition. The linseed cake is brown in colour after the extraction of oil. It contains 21.78% of non nitrogenous extracts, 29.37% lipids and 27.78% protein, 7.02% fibre, 3.40% ash and 10.56% total humidity. It is protein rich feed for livestock.

The optimum seed rate and application of nutrients like nitrogen, phosphorus, potash and sulphur is very important for proper yield of linseed crop (Singh *et al* 2013). In linseed crop nitrogen is most important nutrient, especially under irrigation condition. Due to the deficiency of nitrogen the seed yield of the crop in decrease and seed yield of linseed crop is highly related to N and water availability.

Materials and Methods

Experiment was conducted during *rabi* season of 2019-2020 at the Agricultural Research Farm Dhablan is situated at about 24-46 ^{0}N latitude and 76-

24 ^{0}E longitude at an altitude of about 250 m above the mean sea level. The experiment was laid out in split plot design with 3 replications. From the five randomly selected plants the heights were recorded in cm. The numbers of branches were counted from the sample plants and the values of these were averaged. To study the fresh and dry weight of five plants were collected from the sampling rows of each plot at 30 days interval from sowing till harvest of the crop. These fresh samples were air dried and then dried in an oven at 60 ^{0}C till a constant weight was obtained and weighed to record the average dry weight of the plant. The weight of the sun dried harvested crop was recorded from net plot area and expressed in quintal per hectare after subtracting the seed yield. Seed yield of each plot excluding the border and sampling row was weighed in kilo gram and converted into quintal per hectare.

Results and Discussion

Application of different seed rate treatment had significant effect on number of branches plant^{-1}at all stages of plant growth. Higher no of branches plant^{-1} were recorded at lower level of seed rate in treatment S_1 (30 kg ha^{-1} seed rate) at all the stages of observation 30, 60, 90 DAS and at harvest stage. The treatment S_1 (30 kg ha^{-1}) recorded significantly higher number of branches plant^{-1} (6.08) as compared to other treatments at harvest. However, treatment S_2 (40 kg ha^{-1} seed rate) had statistically at par with the treatment S_1 (30 kg ha^{-1} seed rate) at 30 DAS. The number of branches plant^{-1} was markedly reduced with increasing seed rates from S_1 (30 kg ha^{-1} seed rate) to S_3 (50 kg ha^{-1}). Because at lower seed rate S_1 (30 kg ha^{-1} seed rate), individual plant could utilize more soil moisture, nutrients and solar radiations and hence growth and development were better and leading higher number of branches plant^{-1}. Similarly, results were found by Delesa and Choferie (2015) and Gohil *et al.* (2016).

Data in the Table 2 indicated that number of branches plant^{-1}also significantly influenced by different fertility levels. Amongst the treatments, the treatment F_3 (N:P:K:S @ 60:30:30:30 kg ha^{-1}) recorded higher number of branches plant^{-1} at all the stages of observation and significantly superior over the remaining fertility level treatments. The treatment F_2 (N:P:K:S @ 40:20:20:20) was at par with the treatment F_3 (N:P:K:S @ 60:30:30:30 kg ha^{-1}) in the production of number of branches plant^{-1} at 30 DAS. Higher number of branches plant^{-1} (6.56) were recorded at treatment F_3 (N:P:K:S @ 60:30:30:30 kg ha^{-1}) and lower number of branches plant^{-1} (4.67) at treatment F_0 (control) at harvesting stage. It is possible that at higher levels of NPKS fertilization enhanced cell division and cell multiplication, which brought higher number of branches plant^{-1} (Dohat *et al.* 2019 and Singh *et al.* 2010).

It is clear from the data in the Table 3 that dry matter content was significantly influenced by different seed rates and fertility levels. Amongst the seed rates, the treatment S_3 (50 kg ha^{-1} seed rate) recorded significantly higher dry matter content at all stages of observation. The treatment S_3 (50 kg ha^{-1} seed rate) recorded maximum dry matter content (574.58 g) at harvest and minimum dry matter content (520.58 g)

Table 1: Effect of seed rates and fertility levels on plant height (cm) of linseed

Treatment	Plant height (cm)			
	30DAS	60 DAS	90 DAS	At harvest
Seed rate (kg ha^{-1})				
S1 (30 kg ha-1)	13.25	45.58	77.83	85.50
S2 (40 kg ha-1)	13.92	48.25	79.08	86.83
S3 (50 kg ha-1)	14.50	50.50	81.08	88.67
SE(m)±	0.29	0.69	0.55	0.45
CD (5%)	0.82	1.91	1.53	1.24
Fertility levels (kg ha^{-1})				
F1 (Control)	12.89	42.22	72.67	78.11
F2 (N:P:K:S @ 20:10:10:10)	13.56	47.56	79.78	87.51
F3 (N:P:K:S @ 40:20:20:20)	14.22	49.78	81.22	89.44
F4 (N:P:K:S @ 60:30:30:30)	14.89	52.89	83.67	92.89
SEm±	0.44	0.70	0.62	0.73
CD (5%)	1.27	2.01	1.80	2.10

Table 2: Effect of seed rates and fertility levels on number of branches plant^{-1} of linseed

Treatment	Number of branches plant^{-1}			
	30DAS	60 DAS	90 DAS	At harvest
Seed rate (kg ha^{-1})				
S_1 (30 kg ha^{-1})	2.25	4.17	5.17	6.08
S_2 (40 kg ha^{-1})	2.00	3.42	4.50	5.58
S_3 (50 kg ha^{-1})	1.50	2.83	4.33	5.33
SE(m)±	0.17	0.26	0.14	0.17
CD (5%)	0.46	0.72	0.38	0.46
Fertility levels (kg ha^{-1})				
F_0 (Control)	1.67	2.78	3.44	4.67
F_1 (N:P:K:S @ 20:10:10:10)	1.78	3.22	4.56	5.56
F_2 (N:P:K:S @ 40:20:20:20)	1.89	3.56	4.89	5.89
F_3 (N:P:K:S @ 60:30:30:30)	2.33	4.33	5.78	6.56
SEm±	0.17	0.23	0.23	0.21
CD (5%)	0.48	0.67	0.66	0.59

Table 3: Effect of seed rates and fertility levels on dry matter content (g m^{-2}) of linseed

Treatment	Dry matter content (g)			
	30DAS	60 DAS	90 DAS	At harvest
Seed rate (kg ha^{-1})				
S_1 (30 kg ha^{-1})	80.08	218.42	433.17	520.58
S_2 (40 kg ha^{-1})	87.00	246.58	461.00	549.33
S_3 (50 kg ha^{-1})	94.67	280.25	487.58	574.58
SE(m)±	0.84	0.74	0.70	0.75
CD (5%)	2.33	2.05	1.94	2.10
Fertility levels (kg ha^{-1})				
F_0 (Control)	65.00	170.89	384.22	475.67
F_1 (N:P:K:S @ 20:10:10:10)	82.56	253.67	463.89	551.11
F_2 (N:P:K:S @ 40:20:20:20)	96.22	276.22	485.22	569.56
F_3 (N:P:K:S @ 60:30:30:30)	105.22	292.89	509.00	596.33
SEm±	0.90	1.12	0.97	1.05
CD (5%)	2.59	3.24	2.79	3.03

recorded with treatment S_1 (30 kg ha^{-1} seed rate) at harvest. Dry matter content increase with increasing the levels of seed rate because plant population at higher level of seed rate is more Gohil *et al.* (2016) and Kumar and Kumar (2015) founded the similar trend.

Data given in the table showed that dry matter content plant^{-1} significantly varied with different fertility treatments at all the stages of observation at 30 DAS, 60 DAS, 90 DAS and at harvesting. Amongst all the treatment, the treatment F_3 (N:P:K:S @ 60:30:30:30 kg ha^{-1}) obtained significantly higher dry matter content as compared to remaining treatments at all the stages of observation. Maximum dry matter content (596.33 g) recorded by treatment F_3 (N:P:K:S @ 60:30:30:30 kg ha^{-1}) and minimum dry matter content (475.67 g) recorded by treatment F_0 (control) at harvest stage. Dry matter content was also increase with increasing the fertility levels. This might be possible because of balanced application of NPKS enhanced cell division and cell multiplication, which brought ultimately increase in dry matter content. The results are in accordance with the finding of Gaikwad *et al.* (2020) and Singh *et al.*(2013).

Seed yield significantly varied with seed rate treatments (Tabe 4). The maximum seed yield was recorded in treatment S_2 (40 kg ha^{-1} seed rate) followed

Table 4: Effect of seed rates and fertility levels on seed yield, straw yield and biological yield of linseed

Treatment	Seed yield (q ha^{-1})	Straw yield (q ha^{-1})	Biological yield (q ha^{-1})
Seed rate (kg ha^{-1})			
S_1 (30 kg ha^{-1})	11.36	40.71	52.06
S_2 (40 kg h a^{-1})	14.81	41.31	56.12
S_3 (50 kg ha^{-1})	13.18	43.31	56.49
SE(m)±	0.11	0.34	0.37
CD (5%)	0.31	0.94	1.03
Fertility levels (kg ha^{-1})			
F_0 (Control)	8.80	38.31	47.11
F_1 (N:P:K:S @ 20:10:10:10)	12.57	41.48	54.05
F_2 (N:P:K:S @ 40:20:20:20)	14.37	42.70	57.07
F_3 (N:P:K:S @ 60:30:30:30)	16.72	44.61	61.33
SEm±	0.15	0.82	0.78
CD (5%)	0.43	2.36	2.26

by treatment S_3 (50 kg ha^{-1} seed rate) and S_1 (30 kg ha^{-1}seed rate) respectively. Maximum seed yield (14.81 q ha^{-1}) recorded in treatment S_2 (40 kg ha^{-1} seed rate) and the minimum seed yield (11.36 q ha^{-1}) recorded in treatment S_1 (30 kg ha^{-1} seed rate). Delesa and Choferie (2015) and Meena *et al.* (2011) reported the similar results in seed yield.

It is clear from the results in table that seed yield significantly influenced due to the fertility level treatments. Amongst all the fertility treatments, the treatment F_3 (N:P:K:S @ 60:30:30:30 kg ha^{-1}) obtained significantly higher seed yield as compared to the other treatments. The maximum seed yield (16.72 q ha^{-1}) recorded at treatment F_3 (N:P:K:S @ 60:30:30:30 kg ha^{-1}) and minimum seed yield (8.80 q ha^{-1}) recorded at treatment F_0 (control). It is possible that at higher levels of NPKS fertilization had vigorous plant growth might have produced more photosynthetic, which enhanced the seed yield. This finding is in conformity with the results of Kumar and Deka (2016) and Meena *et al.* (2011).

It is evident from the Table 4 that the straw yield significantly different with seed rate treatment. The straw yield increased with increase in the levels of seed rate. The maximum straw yield was recorded at treatment S_3 (50 kg ha^{-1}seed rate) followed by S_2 (40 kg ha^{-1} seed rate) and S_1 (30 kg ha^{-1} seed rate), respectively. Application of different seed rate treatments had significant effect on straw yield. Maximum straw yield (43.31 q ha^{-1}) recorded in treatment S_3 (50 kg ha^{-1} seed rate) and minimum straw yield (40.71 q ha^{-1}) recorded in treatment S_1 (30 kg ha^{-1} seed rate). Kumar and Deka (2016) reported the similar results in straw yield.

It is indicated from the results in the table that straw yield significantly varied with the fertility treatments. The treatment F_3 (N:P:K:S @ 60:30:30:30 kg ha^{-1})obtained significantly higher straw yield as compared to the other treatments. Application of different fertility levels had significant effect on straw yield. The maximum straw yield (44.61 q ha^{-1}) recorded in treatment F_3 (N:P:K:S @ 60:30:30:30 kg ha^{-1}) and minimum straw yield (38.31 q ha^{-1}) recorded in treatment F_0 (control). The straw yield increased with increase in the fertility levels. It might be possible because balanced application of NPKS enhanced plant growth and produced more photosynthetic. Kumar and Kumar (2015) and Singh *et al.* (2013) reported the similar trends in straw yield.

It is evident from the Table 4 that the biological yield significantly different with the seed rate treatments. The biological yield increased with increase in the levels of seed rate. The maximum biological yield was recorded in treatment S_3 (50 kg ha^{-1} seed rate) followed by S_2 (40 kg ha^{-1} seed rate) and S_1 (30 kg ha^{-1} seed rate), respectively. Application of different seed rate treatments had significant effect on biological yield. Maximum biological yield (56.49 q ha^{-1}) recorded in treatment S_3 (50 kg ha^{-1}seed rate) and minimum biological yield (52.06 q ha^{-1}) recorded in treatment S_1 (30 kg ha^{-1} seed rate). However, the treatment S_2 (40 kg ha^{-1} seed rate) had statically at par with treatment S_3 (50 kg ha^{-1} seed rate). This finding is in conformity with the results of EL-Mohsen *et al.* (2013).

It is clear from the results in the table that biological yield significant varied with the fertility treatments. The treatment F_3 (N:P:K:S @ 60:30:30:30 kg ha^{-1}) obtained significantly higher biological yield as compared to the other treatments. Application of different fertility levels had significant effect on biological yield. The maximum biological yield (61.33 q ha^{-1}) recorded in treatment F_3 (N:P:K:S @ 60:30:30:30 kg ha^{-1}) and minimum biological yield (47.11 q ha^{-1}) recorded in treatment F_0 (control). The biological yield increased with increase in the fertility levels. It might be possible because balanced application of NPKS enhanced plant growth and produced more photosynthates. Devedee *et al.* (2017) and Kumar and Deka (2016) reported the similar result in biological yield.

Conclusion

On the basis of the results from the present investigation, it can be concluded that maximum seed yield (14.51 q ha^{-1}), gross return (133275 Rs ha^{-1}), net return (99475.06 Rs ha^{-1}) and B:C ratio (2.91) was obtained with application of treatment S_2 (40 kg ha^{-1}seed rate) whereas, the number of branches, capsules plant^{-1}and test weight showed the reverse trends with increasing seed rate from 30 to 50 kg ha^{-1}.Application of treatment F_3 (N:P:K:S @ 60:30:30:30 kg ha^{-1}) produced significantly higher growth attributes, seed yield (16.72 q ha^{-1}), gross return (150490 Rs ha^{-1}), net return (114579.15 Rs ha^{-1}) and B:C ratio(3.18).

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