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EFFECT OF DIFFERENT DOSES OF FERTILIZERS ON YIELD AND NPK UPTAKE OF LINSEED *(LINUM USITATISSIMUM* L.)

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Abstract

Field experiments were conducted to find out production potential of linseed (*Linum usitatissimum*) in relation to fertility levels and varieties. The treatments comprised of four fertility levels of N:P:K in kg/ha *viz.* F_1 - control, F_2 - 37.5 : 22.5 : 15, F_3 - 50 : 30 : 20 and F_4 - 62.5 : 37.5 : 25 allotted to main plots and four varieties (LC-2023, LC-2063, LC-54 and local variety) in sub-plots. Increasing fertilizer dose from F_1 to F_3 significantly increased growth (plant height and number of branches per plant), yield attributes (capsules per plant and seeds per capsule) and seed and stover yield of linseed. However, further increase in fertilizer dose to F_4 did not increase the growth, yield attributes and seed and stover yield significantly. Regarding varietal effect, linseed variety LC-2063 marked its superiority over other three varieties by recording higher values of growth parameters as well as yield attributes. The values of RWUE showed increasing trend with increasing fertility levels and in case of varieties, V_2 (LC 2063) registered highest values of RWUE.

Introduction

Linseed (*Linum usitatissimum* L.) is an important oilseed crop and cultivated primarily for oil meant for edible as well as industrial purposes. About 80 per cent of oils is used for paints, varnishes, a wide range of coating oils, linoleum, pad and printing inks, leather finishing, its fiber has more strength and durability which blends very well with wool, cotton, silk etc. Flax fibre are amongst the oldest fibre crops in the world after silk (Hussain *et al.* 2009). The oil cake left, after the oil is pressed out is a most valuable feeding cake, perhaps the most favourite cattle feed. The oil cake is a good feed for milch cattle and poultry and hence priced 50% higher than rapeseed-mustard cake. It is good in taste and contains 36% protein, 85% of which is digestible. It is also used as organic manure. It contains about 5% N, 1.4% P_2O_5 and 1.8% K_2O.

India stands second in linseed cultivation (17.15 %) in area after Canada in the world, but stands at fourth place (7.74%) in production, with poor productivity of 502 kg/ha. The national productivity of linseed is far below to experimental fields' yield. The linseed productivity suffers due to poor inputs and moisture management. Linseed is cultivated on an area of 12 m/ha, in India and contributes about 31% of total oilseed production. The States producing linseed are Madhya Pradesh, Rajasthan, Himachal Pradesh and some districts of Punjab, Bihar and Uttar Pradesh. In Jammu province of Jammu and Kashmir state linseed covers an area of about 0.247 m ha with an average yield of 552 kg/ha.

The yield of linseed can be increased by more than 100% over the prevailing management practices under rainfed condition with proper fertilization, weed control and plant protection measures and out of these practices, fertilizer was more effective (Singh and Verma 1998). The reasons for low yield of linseed are poor soil fertility, inadequate use of fertilizer and traditional crop management practices.

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In this respect, fertilization the most important crop management techniques is known to affect seed yield (Dordas 2010). In dryland area fertility status mainly (NPKS), sowing time, soil moisture, seed density, inter-culture operation like hoeing and weeding are the key factor that decide crop yield and quality (Singh *et al.* 2007). Maize-linseed is one of the cropping systems of this area. With the availability of high yielding hybrid/composite varieties of maize, this cropping system is becoming more remunerative as linseed can be taken up with limited irrigation during winter. Of late there is growing awareness among farmer's to cultivate linseed crop. Keeping in view the above facts the present investigation was undertaken to evaluate the effect of different fertility levels and varieties on growth, yield attributes, and yield of linseed under sub tropical conditions of Jammu.

Materials and Methods

The experiment was conducted from the Kharif season of 2010-2011 to Rabi season of 2011-12 at the Research Farm of Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Chatha, (32^o 40' N, 74^o 58' E 320 m amsl). The mean annual rainfall of Jammu is 1150 mm and more than 80% generally occurs during south-west monsoon season (July-September). The rainfall received during 2010-2011 crop season was slightly higher than received during 2011-2012. Soil of the experimental field was slightly alkaline in nature (pH 7.6), low in organic C (0.32%) and available N (212 kg/ha) and medium in available P (13.4 kg/ha) and K (128.8 kg/ha) and the soil texture was sandy clay loamy. The experimental layout was under fodder crop for two seasons before sowing of experimental crop.

The experiment started from the Kharif seasons of 2010 with maize crop (Kanchan-517) being taken up, as a uniform blanket crop without any treatments imposed. In the succeeding Rabi season, treatments were imposed on linseed. The experiment was laid out in three times replicated split plot design, where main plots received four fertility levels (F_1-Control, F_2-37.5 : 22.5 : 15, F_3-50 : 30 : 20 and F_4 - 62.5 : 37.5 : 25 of N, P and K kg/ha, respectively), while in sub plots four linseed varieties *viz*. LC 2023, LC 2063, LC 54 and local variety were allotted. Maize crop was sown at a spacing of 60 cm × 20 cm using seed rate of 20 kg/ha. And linseed crop was sown at a spacing of 30 cm × 10 cm using seed rate of 25 kg/ha. Recommended NPK dose for maize crop was 90-60-30 kg/ha, respectively, whereas, linseed was given NPK dose as per the treatment, using urea, diammonium phosphate and muriate of potash as source of fertilizers. Full dose of P and K along with half of N were applied as basal in both the crops and remaining N was applied in two splits at 30 and 60 DAS to linseed crop and at 25 and 45 DAS to maize crop. Data on various yield attributes, seed and stover yield of maize and linseed were calculated as per the standard procedures. Plant NPK uptake were also estimated. Both the crops were irrigated as and when required. The available N, P and K were estimated by following standard methods, i.e. available N by alkaline potassium permanganate method (Subbiah and Asija 1956), available P by Sodium bicarbonate method (Olsen *et al*. 1954) and available K by ammonium acetate method (Merwin and Peech 1950).

Rainfall data was recorded at Meteorological Observatory, SKUAST-J, Chatha and the following indices was calculated:

a. Rain water use efficiency (RWUE): RWUE is the ratio of total grain and biological yields (kg/ha) by the total rainfall (mm) received during the cropping period.

$$\text{RWUE (kg/ha/mm)} = \frac{\text{Grain/biological yield (kg/ha)}}{\text{Total rainfall (mm)}}$$

Results and Discussion

It is evident from the data that growth and yield attributes exhibited significant increase in normal course of investigation. Application of phosphorus (P) to linseed hastens development and promotes its deep penetration, which prevents lodging and takes care of plant during time of moisture stress. And application of potassium (K) could increase the effect of N fertilization and mitigate the injurious effect of excessive N and oil flax requires more N than fibre flax. However, recent studies under AICRP on linseed revealed, that dual purpose linseed as well as seed type linseed responds equally to fertilizer application. Increasing fertility level from F_1 to F_4 significantly increased all the growth parameters. However, higher dose of fertility level helps in better crop growth and proportionately brought higher production of linseed. Plant height and number of branches per plant increased significantly with increasing fertilizer dose from (F_1) control to (F_3) 50 : 30 : 20 kg/ha of N-P-K, during both the crop seasons (Table 1). Further increase in fertilizer dose to (F_4) 62.5 - 37.5-25 kg/ha of N-P-K did not prove instrumental in enhancing various growth characters. This might have been due to balanced application of NPK which enhanced cell division, cell multiplication and tissue differentiation, which ultimately increased plant height and branching in plant, and led to increase in yield attributes *viz.* number of capsules per plant, number of seeds per capsule and 1000-seed weight. The results were corroborated with the findings of Meena *et al.* (2011). According to Khare *et al.* (1996) nitrogen and sulphur application greatly influences chlorophyll synthesis, carbohydrate as well as metabolism and finally results in growth characters, contributing to higher biomass in plants. Among the varieties, LC 2063 showed better performance of growth as well as yield attributing characters than other three varieties (LC 2023, LC 54 and local variety). LC 2063 recorded significantly more plant height and branches per plant. Number of capsules per plant and number of seeds per capsule were found to be significantly maximum under variety LC 2063. The varieties LC 2023 and LC 54 remained at par with each other. However, 1000-seed weight remained unaffected by varietal affect (Table 1).

Seed and stover yield (Table 1) of linseed were significantly affected with variations in fertility levels. Significant reduction in capsules/plant, seeds/capsule and 1000-seed weight were recorded at lower rates of NPK application and increasing fertility levels resulted to enhance cell and tissue differentiation. The increase in attributing characters with the increase in NPK of linseed levels has been reported by Khare *et al.* (1996). The favorable effect of NPK application on yield attributing characters was finally reflected in seed yield of linseed crop. With the increment in fertilizer dose from F_1 to F_4, increase in seed and stover yield of linseed crop was marked only up to F_3 level (50 : 30 : 20 kg/ha of N : P_2O_5 : K_2O) of fertilizer dose. However, higher stover yield of linseed was recorded at higher rates of NPK application. This could be attributed to the increased plant height, branching and dry matter accumulation with increasing levels of NPK application. Thereafter, the increase in fertilizer dose did not increase seed and stover yield significantly. This may be due to optimal supply of nutrients to the linseed crop upon use of fertilizer dose of 50 : 30 : 20 kg/ha thereby resulting in better growth and development of the crop. The results are in conformity to the findings of Tanwar *et al.* (2011). Recommended dose of fertilizer may have supplied nutrients to crop in optimum and balanced proportion required for its better growth and development.

Regarding the varieties, LC 2063 produced significantly highest seed and stover yield as compared to other varieties tried, *viz.* LC 2023, LC 54 and local variety. Variety LC 2063 recorded approximately 33 per cent increase in yield over local variety. Higher seed and stover yield of linseed variety LC 2063 may be on account of better growth and yield attributes of this variety,

Table 1. Effect of fertility levels and varieties on yield attributes and yield of linseed.

Treatment	Plant height (cm)		Branches/ plant		Capsules/ plant		Seeds/ capsule		1000-seed weight (g)		Seed yield (q/ha)		Stover yield (q/ha)	
	I	II	I	II	I	II	I	II	I	II	I	II	I	II
Fertility levels														
F_1	49.18	51.73	7.25	6.91	30.17	30.43	5.44	6.18	7.50	7.02	5.79	6.07	10.55	10.09
F_2	60.72	64.48	8.21	7.96	36.44	37.93	6.65	7.55	7.88	7.95	8.49	8.67	16.99	16.67
F_3	72.31	78.54	9.28	8.55	43.83	46.20	7.90	8.97	8.04	8.22	10.60	11.49	17.70	22.36
F_4	77.81	84.71	9.71	9.25	47.16	49.83	7.98	9.06	8.12	8.75	11.12	12.22	18.01	24.12
CD (0.05)	10.47	11.56	0.94	NS	6.35	7.04	1.11	1.26	NS	NS	0.64	2.46	0.45	5.60
SEm±	3.51	4.26			2.13	2.50	0.32	NS	0.31		0.18	0.72	0.13	2.87
Variety														
V_1	67.25	69.32	8.64	8.34	40.76	40.78	7.15	8.12	7.94	8.04	9.20	10.26	16.48	19.20
V_2	70.63	77.62	9.38	9.03	42.20	45.66	7.37	8.37	8.15	8.44	9.95	11.87	17.12	21.80
V_3	64.83	67.86	8.37	7.90	39.90	39.92	6.99	7.94	7.70	7.75	8.99	9.06	16.18	17.90
V_4	60.58	62.93	8.05	7.40	36.72	37.02	6.48	7.36	7.75	7.60	7.91	7.31	13.47	15.15
CD (0.05)	5.01	4.21	0.30	NS	3.04	2.48	NS	NS	NS	NS	0.21	1.51	0.37	2.07
SEm±	1.78	1.44			1.08	0.85	0.42	0.50	0.30		0.07	0.51	0.12	0.70
Maize														

I - First year, II - Second year.

which may be genotypic character of this variety. Whereas, the variety LC 2023 produced seed and stover yield at par with variety LC 54 but both recorded superiority over local variety. It corroborated the findings of Bastia and Mohanty (2001) that high yielding varieties of linseed respond well to moderate dose of fertilizers, as well as to Hussain *et al.* (2009), that application of recommended dose of fertilizers would be helpful in realizing yield potential of the linseed varieties.

Table 2. Effect of fertility levels and varieties on nutrient uptake (kg/ha).

Treatment	N		P		K	
	I	II	I	II	I	II
Fertility levels						
F_1	23.72	30.39	7.14	7.81	21.35	26.24
F_2	34.62	33.00	9.37	9.78	32.36	30.66
F_3	40.68	46.32	11.49	13.21	40.03	43.23
F_4	44.27	51.12	12.39	14.11	41.55	45.36
CD (0.05)	3.60	11.80	1.33	3.31	6.06	11.60
SEm±	1.04	3.41	0.30	0.96	1.35	4.20
Variety						
V_1	36.64	41.20	10.23	11.24	34.61	36.91
V_2	39.57	47.22	11.80	12.86	37.00	41.48
V_3	35.54	38.85	10.04	11.03	33.61	34.24
V_4	31.53	33.06	8.98	9.78	30.07	32.87
CD (0.05)	1.10	6.33	1.03	2.60	1.98	7.83
SEm±	0.37	2.17	0.33	0.90	0.64	2.81

I - First year, II - Second year

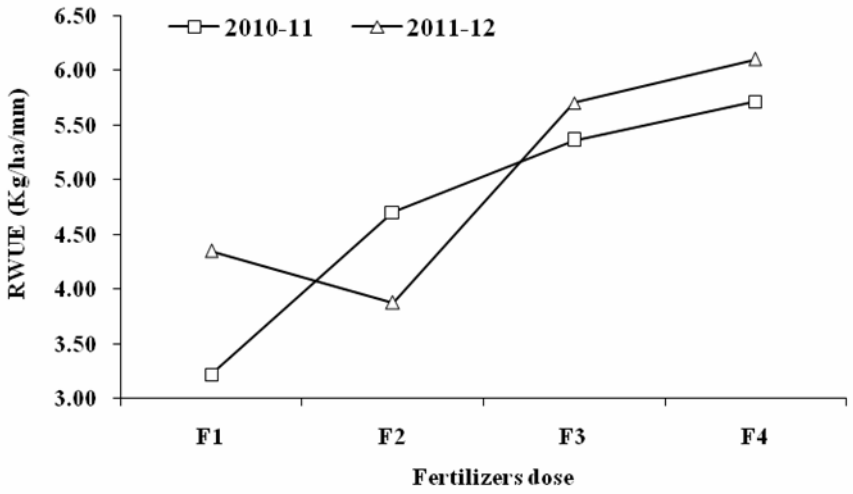

Fig 1. Rain water use efficiency (RWUE) of linseed crop as affected by fertility levels.

Uptake of nutrients (N, P and K) in linseed crop (Table 2) increased significantly with increase in fertility levels from F_1 to F_3. Further increase in fertility level to F_4 could not bring

about significant increase in N, P and K uptake. The increase in nutrient content was in consonance with higher seed and biological yields and increase in nutrient content in plant tissues with increase in fertility levels. The results are in conformity to the findings of Tanwar *et al.* (2011). As regards to varietal effect, variety LC 2063 remained superior to other varieties by recording higher nutrient content. Mohapatra *et al*. (2009) confirmed these findings.

The values of rain water use efficiency (RWUE) showed an increasing trend with respect to the different fertilizers treatments, however, the values of RWUE obtained in the year 2011-2012 were higher as compared to the year 2010-2011 except for the F_2 treatment (Fig. 1). In case of varieties, V_2 (LC 2063) registered the highest values of RWUE and the variety V_4 (local variety) recorded the lowest values of RWUE in both the years under study (Fig. 2).

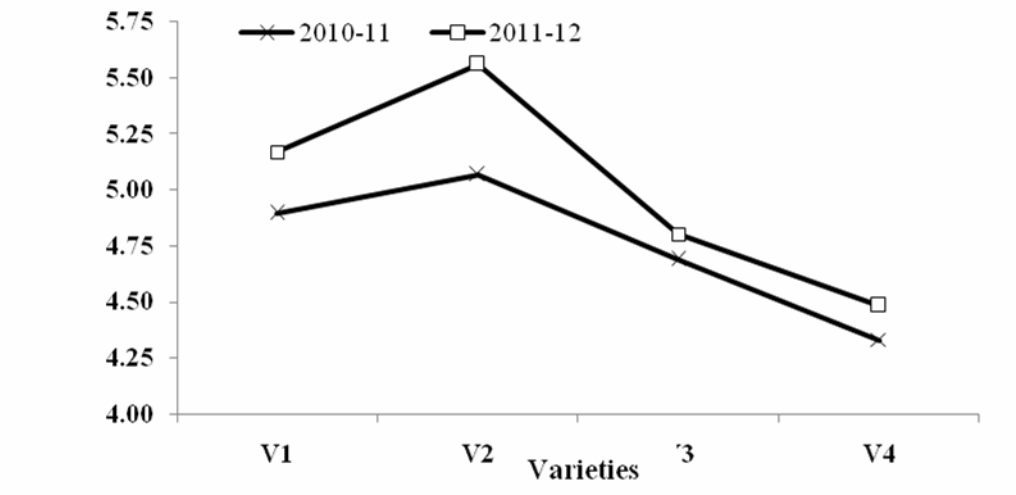

Fig 2. Rain water use efficiency (RWUE) of linseed crop as affected by different varieties.

The experimental results revealed that LC 2063 variety performed better than other three varieties during both the years. Increasing fertility level from F_1 to F_4 increased linseed seed and stover yield, but significantly only up to F_3 level of fertilizer dose.

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