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Water requirement, water use efficiency, consumptive use, and yield and quality parameters of Linseed (*Linum usitatissimum* L.) varieties as influenced by fertility levels, irrigation scheduling

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ABSTRACT : A field experiment was conducted at Agricultural Research Station Ummedganj, Kota, to find out the effect of fertility levels and irrigation schedules on linseed varieties on vertisols of south-eastern Rajasthan during the year 2000-01 and 2001-02. on the basis of two years experimentation, result revealed that variety Meera consistently recorded significantly higher seed (15.39 qha^{-1}), straw (20.33 qha^{-1}), biological yield (35.72 qha^{-1}), net monetary return (14620/ha) and B: C ratio (1.61) as compared to variety Rashmi in linseed. Though the highest seed, straw and biological yield was recorded with IW/CPE ratio of 0.7 but it was found statistically at par with IW/CPE ratio of 0.5. Linseed variey Meera showed significantly higher water use efficiency (7.81$kgha^{-1}$ mm) as compare to Rashmi (7.11$kgha^{-1}$ mm). The crop under influence of fertility level 80 kg N + 30 kg $P_2O_5ha^{-1}$recorded higher water use efficiency (8.81 $kgha^{-1}$ mm). The mean increase in water use efficiency at 80 kg N + 30 kg $P_2O_5ha^{-1}$ was 20.62 and 87.84 per cent higher over 40 kg N + 30 kg $P_2O_5ha^{-1}$ and control, respectively.

Key Words : Linseed, Nitrogen, Phosphorus, Potassium, Uptake

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Among the oil seed crops grown during *Rabi*, linseed is next in importance to rapeseed and mustard in area as well as production. This crop is often grown on marginal and sub marginal. Mostly on rainfed soil as pure or mixed or intercrop. The main reason for low yield appears to be low soil moisture and nutrient status. Particularly at different crop stages. Since the crop is mostly grown on conserved soil moisture where application of nutrient is almost negligible. Recently, several high yielding varieties of the crop have been released which produce seed yield more than 20 qha^{-1}. Thus, these varieties have turned this crop into a highly remunerative crop. Among the agronomic practices known to augment the crop yield, moisture supply is of vital importance. Water deficits can however, reduce yield seriously if they occur at certain periods during the growth of the crop (Gopalkrishan *et al.*, 1996). Nitrogen is an important constituent of protein, enzymes and chlorophyll and is involved in all processes associated protoplasm, enzymatic reactions and photosynthesis. Nitrogen plays a major role in early establishment of leaf area, increasing photosynthesis and root development to enable more efficient use of water.

Application of phosphorus gives superior quality of seed, help in photosynthesis, respiration, protein synthesis, lipids, sugar and other essential compounds. Phosphorus involve in energy transfer reaction. ATP to NADP. Linseed crop responded to phosphorus application up to 30kg $P_2O_5ha^{-1}$ (Agarwal *et al.*, 1999). In the light of above context, this crop has great potential for improvement on vertisols of South-eastern Rajasthan under irrigated conditions.

RESEARCH PROCEDURE

The field experiment was at Agricultural Research Station Ummedganj, Kota, during *Rabi* season 2000-01 and 2001-02 under irrigated conditions. The soil of experiment site was clay loam pH 7.73 and electrical conductivity 0.30 dSm^{-1}. The available organic carbon 5.69g kg^{-1}, N, P and K status being medium 368.35, 23.90 and 3111.39$kgha^{-1}$, respectively. The

experiment was laid out in split plot design with 3 replications. The treatment included, main plot factor varieties (2)–(i) Meera (ii) Rashmi and irrigation schedules (3)- (i) IW/CPE of 0.3 (ii) IW/CPE of 0.5 (iii) IW/CPE of 0.7 and sub plot factor fertility levels (4)- (i) Control (ii) 40kg N + 20kg P_2O_5ha^{-1} (iii) 80kg N + 30kg P_2O_5ha^{-1} (iv) 120kg N + 40kg P_2O_5ha^{-1}. Total numbers of treatment combinations were 24.The crop was raised from November to March in the same field for two years during 2001 and 2002. The fertilizer dose as per treatment was applied at the time of sowing. A pre-sowing irrigation of 100mm was applied uniformly to experimental plot. Supplemental post irrigation 60mm depth each measured by parshall flume were applied when the specified IW/CPE ratio has reached. Check basin method of irrigation was used. The data on N, P and K content and its uptake by seed and straw were as standard procedure (Piper, 1950).

RESEARCH ANALYSIS AND REASONING

The results obtained from the present investigation have been discussed in the following sub heads:

Yield attributes and yield:

Result revealed that variety Meera consistently recorded significantly higher seed (15.39 qha^{-1}), straw (20.33 qha^{-1}) and biological yield (35.72 qha^{-1}) as compared to variety Rashmi in linseed (Table 1). Application of various IW/CPE ratios recorded significantly effect on seed, straw and biological yield. Irrigation at IW/CPW ratio of 0.5 gave significantly higher seed, straw and biological yield as compared to IW/CPE 0.3. Though the highest seed, straw and biological yield was recorded with IW/CPE ratio of 0.7 but it was found statistically at par with IW/CPE ratio of 0.5. Application of fertilizer @ 80 kg N + 30kg P_2O_5ha^{-1} gave significantly higher number of capsules, number of seeds per capsule, weight of seeds/capsule, weight of single seed, straw and biological yield over their preceding fertility levels but was found statistically at par with succeeding levels in fertility in linseed, Similar findings were observed by Pandey *et al* (2002) and Dubey and Zubal (2001). This could be ascribed due to profuse branching, formation of maximum flowers, increased availability of nutrients and photosynthates to these developing structure seems to have resulted in greater retention of flowers and the develop into fertile fruits. These results corroborate with the findings of Gopalkrishana *et al.* (1996) and Vasistha (1993).

Water requirement, water use efficiency and consumptive use:

Linseed variey Meera show significantly higher water use efficiency (7.81kgha^{-1} mm) as compare to Rashmi (7.11kgha^{-1} mm). The crop under influence of fertility level 80 kg N + 30 kg P_2O_5ha^{-1}recorded higher water use efficiency (8.81 kgha^{-1} mm). The mean increase in water use efficiency at 80 kg N + 30 kg P_2O_5ha^{-1} was 20.62 and 87.84 per cent higher over 40 kg N + 30 kg P_2O_5ha^{-1} and control, respectively. The results showed that

Table 1 : Effect of varieties, irrigation schedules and fertility levels on seasonal consumptive use, water use efficiency yield and economics of linseed

Treatments	Seasonal consumptive use (mm)	Water use efficiency (kg/ha mm)	Water requirement (mm)	Seed yield (q/ha)	Straw yield (q/ha)	Biological yield (q/ha)	Net monitory return (Rs/ha)	B:C ratio
Varieties								
Meera	205.68	7.81	303.28	15.39	20.33	35.72	14620	1.61
Rashmi	205.58	7.11	304.85	14.03	18.73	32.76	12540	1.38
S.E.±	1.91	0.16	2.97	0.24	0.39	0.42	363	0.04
C.D. (P=0.05)	NS	0.57	NS	0.75	1.21	1.32	1146	0.13
IW/CPE ratio								
0.3	156.39	8.30	259.31	12.69	17.45	30.14	10964	1.28
0.5	211.71	7.51	304.82	15.47	20.17	35.64	14732	1.63
0.7	249.31	6.57	350.34	15.97	20.98	36.94	15044	1.58
S.E.±	2.34	0.19	3.64	0.29	0.47	0.68	445	0.05
C.D. (P=0.05)	7.39	0.62	11.47	0.92	1.49	2.14	1403	0.16
Fertility levels (N+P_2O_5kg/ha)								
Control	202.87	4.69	301.14	9.10	12.54	21.63	5998	0.76
40+20	204.60	7.30	303.76	14.30	19.26	33.56	13204	1.53
80+30	206.91	8.81	305.72	17.48	22.76	40.23	17472	1.90
120+40	208.14	9.02	305.33	17.97	23.58	41.54	17646	1.80
S.E.±	1.81	0.16	4.04	0.30	0.39	0.55	450	0.05
C.D. (P=0.05)	NS	0.46	NS	0.85	1.10	1.58	1293	0.15

NS=Non-significant

Table 2 : Effect of varieties, irrigation schedules and fertility levels on oil content, oil yield, protein content, iodine number and saponification value of linseed

Treatments	Oil content (%)	Oil yield (kg/ha)	Protein content (%)	Iodine no.	Saponification value
Varieties					
Meera	42.47	664	11.50	171.19	191.75
Rashmi	40.48	576	11.53	170.93	191.76
S.E.±	0.49	13	0.06	1.33	0.71
C.D. (P=0.05)	1.56	43	NS	NS	NS
IW/CPE ratio					
0.3	39.48	507	10.82	167.67	191.81
0.5	42.19	661	11.74	172.02	191.75
0.7	42.76	691	11.98	173.49	191.71
S.E.±	0.61	17	0.07	1.63	0.87
C.D. (P=0.05)	1.91	52	0.24	NS	NS
Fertility levels ($N+P_2O_5$kg/ha)					
Control	38.22	349	11.13	173.62	191.69
40+20	41.39	594	11.42	171.49	191.91
80+30	42.89	753	11.69	169.88	191.72
120+40	43.41	783	11.82	169.25	191.69
S.E.±	0.50	16	0.06	1.22	0.81
C.D. (P=0.05)	1.44	44	0.19	NS	NS

NS=Non-significant

increase in irrigation frequency *i.e.* 2 to 4 irrigation significantly increased consumptive use of water by the crop but reduced water use efficiency. The crop under 4 irrigations consumed the maximum amount of water (249.3 mm) compared to least under 3 irrigations (156.4 mm) However reduction under WUE was estimated under 4 irrigations (6.57 kg ha^{-1} mm) compared to 2 irrigation (8.30 kg ha^{-1} mm). The consumptive use of water by the crop is dependent on availability of water and overall crop growth. The reduction in WUE with increase in irrigation level suggests poor efficiency of crop to utilize favourable environmental conditions towards economic yield formation. Similar results were also observed by Singh *et al.* (2000).

Quality parameters and yield:

Significantly higher oil content (42.47%) and oil yield (664 kg/ha) was recorded by variety Meera as compared to Rashmi (Table 2). Increase in irrigation levels significantly increased oil content and production by linseed crop. Irrigation at IW/CPE ratio of 0.7 gave increasing trend of oil yield (366.12 kg/ha) The increase in oil content might be due to reduced irrigation intervals enhancing the carbohydrate accumulation. The regression analysis showed strong influence of seed yield and oil content on oil yield. A unit increase in oil production (q/ha) increased seed yield the magnitude of 0.020 and 0.019 q/ha, respectively. These finding are in conformity with those reported by Foster *et al.* (1998). Application of fertilizer at 80 kg N + 30 kg $P_2O_5ha^{-1}$ significantly increased oil content and oil yield over 40 kg N +20 kg $P_2O_5ha^{-1}$ and control. The increasing trend with 80 kg N + 30kg $P_2O_5ha^{-1}$ was to the tune of 3.62 and 12.21 per cent in oil content and 26.82 and 115.70 per cent in oil yield over 40 kg N +20 kg $P_2O_5ha^{-1}$ and control, respectively.

Economics:

The variety meera recorded significantly higher net monetary return (14620/ha) and B: C ratio (1.61) compared to Rashmi. Irrigation at 0.5 IW/CPE ratio resulted significantly higher net monetary returns (14732/ha) and B: C ratio (1.63). Application of fertilizers @80+30 Kg N and P2O5/ha recorded significantly higher net monetary return (17472/ha) and B: C ratio (1.90) as compared to its lower levels. But it was at par with application of fertilizers @ 120 +40 Kg N and P_2O_5/ha.

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