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Resource constraints analysis in linseed (*Linum usitatissimum* L.)

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Abstract
A field experiment was conducted during *rabi* season of 2020-2021 at Experimental Farm Agronomy Section, Oilseeds Research Station, Latur to analyse the effect of various constraint on growth and yield attributes of linseed (*Linum usitatissimum* L.) in vertisol. The topography of experimental field was uniform and fairly levelled. The soil of experimental plot was clayey in texture, moderately alkaline in reaction having p^H 7.02 with chemical composition such as low in available nitrogen (231 kg ha^{-1}), very low in available phosphorous (8.57 kg ha^{-1}) and very high in available potassium (579.80 kg ha^{-1}). Soil was well drained which was favourable for optimum growth. The experiment was laid out in Randomized Block Design with eight treatments, replicated thrice. The result showed that the application of full package of practices (T_1) recorded higher growth, yield attributes and seed yield (1928 kg ha^{-1}) in linseed production. Among the different constraints of the single production factor, RDF was found to be the most crucial factor caused yield losses of up to 24%, followed by weeding (23%) and plant protection (18%) as compared to full package of practices. Among the two factor production constraints, RDF combined with weeding (T_5), RDF with plant protection (T_6) and weed management with plant protection (T_7) caused yield reduction up to 49%, 47% and 40%, respectively and was reported as major resource constraints in linseed production. Regarding the combination of three factor production constraints, RDF, weed management and plant protection caused yield reduction of52% as compared to full package of practices (T_1).

Keywords: linseed, fertilizers, weeding, plant protection, constraints, yield reduction

Introduction
Linseed (*Linum usitatissimum* L.) is the one of the oldest cultivated plant with production in the fertile crescent dating back to 7000 BC. It is annual herb belongs to the genus Linum and family Linaceae. Seed contains 33 to 47% oil as well as contain 21-25% protein, 28% dietary fiber, 7.7% moisture and 3.3% ashes. About 80% oil goes to industry, which is used for the preparation of paints, varnishes, printing ink, oil cloth, soap, patent, leather and waterproof fabrics due to its quick drying property. The oil cakes of linseed are most valuable feeding cake perhaps the most favourite cattle feed. It contains 36% protein out of 85% protein is digestible. It is also used as organic manure and contain about 5% nitrogen, 1.4% phosphorus and 1.8% potassium. Linseed plays vital role in the treatment of cnacer, arthritis and cardiological disease because of high alpha linoleic acid (66%) content (Kalal *et al*., 2018) [1]. Crop production mainly depends on the climatic factors as well as agronomic practices. Among the agronomical practice application of fertilizers, weed management and plant protection plays vital role in maximizing seed yield of linseed. The various factors *viz.*, fertilizer, weeding and plant protection contributes towards the establishment of the crop stand as well as their growth, which ultimately turns into final seed yield of crop. It is important to know which constraints affect the production so that attempt can be encouraged against that constraint to find out a solution. Resource constraints refers to the limitations on basic inputs available. By finding out the major production constraints of linseed production resource constraints make the limitations on basic inputs of agriculture and some cultural practices such as weeding, fertilizer and plant protection which are necessary for better growth and development of crop and higher yield as well as economical profits. Keeping these facts in view, the present investigation entitled "Resource constraints analysis in linseed (*Linum usitatissimum* L.)" in vertisolwas carried out to analyse the effect of various constraint on growth and yield attributes of linseed and to access the losses due to constraint.

Materials and Methods

The experiment was conducted during *rabi* season of 2020-2021 at Experimental Farm Agronomy section, Oilseeds Research Station, Latur, to study the effect of various constraint on growth and yield attributes of linseed and quantified the losses due to constraints in linseed production. The soil of experimental plot was clayey in texture, moderately alkaline in reaction having p^H 7.02 with low in available nitrogen (231 kg ha^{-1}), very low in available phosphorous (8.57 kg ha^{-1}) and very high in available potassium (579.80 kg ha^{-1}). Soil was well drained which was favourable for optimum growth. The experiment was laid out in Randomized Block Design. The eight treatments were replicated thrice. The treatments were T_1: Full package of practices, T_2: T_1- RDF, T_3: T_1- Weeding,T_4: T_1 - Plant Protection,T_5 : T_1- (RDF + Weeding), T_6 : T_1- (RDF + Plant Protection), T_7: T_1- (Weeding + Plant Protection),T_8 :T_1 - (RDF + Weeding + Plant Protection).The gross and net plot size of each experimental unit was 5.40 m x 4.50 m and 4.5 m x 3.9 m, respectively. Sowing was done by dibbling method by using seed rate 25 kg ha^{-1}. The recommended dose of fertilizer for linseed crop was 60: 30: 00: 15 kg NPKS ha^{-1}.The fertilizers were applied according to the treatments before sowing. Sowing was done on 14th Nov, 2020. The recommended cultural practices were undertaken. RDF, weeding and plant protection measures were applied according to the treatments. The dose of fertilizers (Nitrogen, phosphorus and sulphur) was applied as per treatments through the fertilizers Urea, DAP and Bensulf. Data obtained on various variables were analyzed by analysis of variance method (Panse and Sukhatme, 1967) [5].

Results and Discussion

Growth attributes

The growth attributes namely plant height (cm), number of branches per plant, plant spread (cm) and dry matter accumulation (g) per plant of linseed crop were influenced significantly due to effect of various treatments (Table 1).

The adoption of full package of practices recorded maximum value of plant height, number of branches per plant, plant spread (cm) and dry matter accumulation (g) per plant which was at par with T_4 (T_1- Plant Protection), T_3 (T_1-Weeding) and T_2 (T_1-RDF) and found significantly superior over rest of the resource constraint treatments. Combined production factor constraints showed lower value of above parameters. The positive effect of full package on these parameters of linseeds might be due to the adequate supply of nutrients which enhanced cell elongation and cell division and resulted in optimum growth, weed management and pest management also provided good environment for crop growth. These results are in consistent with those recorded by Kalal *et al.*, (2019), Lawania *et al.*, (2015) [3], Mishra and Gaur (2013) [4], Krishna *et al.*, (2018) [2].

Dry matter accumulation per plant was reduced where RDF, weed management and plant protection constraints were combined. This might be due to crop weed competition for nutrients, water, space, light etc. which ultimately reduced the dry matter accumulation per plant. The similar results were also reported by Kalal *et al.*, (2019), Puhup and Dwivedi (2019) [6], Krishna *et al.*, (2018) [2].

Yield attributes

The yield attributing characters of linseed *viz.*,Number of capsule, weight of capsules(g), weight of seed(g) per plant and seed yield (kg ha^{-1}) were influenced significantly due to effect of various resource constraints (Table 2). The higher number of capsules per plant (82.80), were obtained with application of full package of practices which was significantly superior over all the treatment exceptT_3 **(**T_1**–** Weeding) and T_4**(**T_1 **-** Plant Protection). The highest weight of capsules (g), weight of seed(g) per plant and seed yield (kg ha^{-1}) of linseed observed with application of full package of practices which was significantly superior over rest of the treatments. These results could be due to application of full package which favored growth attributes along with lower infestation of insect pests, diseases and weeds. Similar results were found by Kalal *et al.*, (2018) [1], Krishna *et al.*, (2018) [2], Tiwari *et al.*, (2018) [8], Puhup *et al.*, (2019) [6].

Yield reduction due to resource constraints

Among the different constraints of the single production factor, RDF was found to be the most crucial factor caused yield losses of up to 24%, followed by weeding (23%) and plant protection (18%) as compared to full package of practices. Among the two factor production constraints, RDF combined with weeding (T_5), RDF with plant protection (T_6) and weed management with plant protection (T_7)caused yield reduction up to 49%, 47% and 40%, respectively. Regarding the combination of three factor production constraints, RDF, weed management and plant protection caused yield reduction of 52%as compared to full package of practices (T_1). These results were inconformity with the results of Krishna *et al*, (2018) [2], Sagvekar *et al.*, (2017) [7].

Table 1: Effect of various treatments on growth attributes of linseed

Treatments	Plant height/ plant (cm) at harvest	No. of branches /plant at harvest	Plant spread / plant (cm) at harvest	Dry matter / plant (g) at harvest
T_1 : Full Package	40.92	6.90	20.01	9.05
T_2 : T_1– RDF	38.65	6.27	18.15	8.10
T_3 : T_1– Weeding	38.96	6.40	18.49	8.40
T_4 : T_1 - Plant Protection	40.33	6.60	19.79	8.60
T_5 : T_1- (RDF + Weeding)	34.23	5.87	17.11	7.07
T_6 : T_1- (RDF + Plant Protection)	36.01	5.93	17.47	7.31
T_7 : T_1- (Weeding + Plant Protection)	36.11	6.00	17.52	7.52
T_8 : T_1 - (RDF + Weeding +Plant Protection)	33.05	5.40	16.02	6.67
SE ±	1.44	0.27	0.80	0.42
C.D. at 5%	4.36	0.81	2.43	1.27
General Mean	37.28	6.17	18.07	7.84

Table 2: Effect of various treatments on yield attributing characters and yield of linseed

Treatments	Number of capsules plant^{-1}	Weight of capsules plant^{-1}	Weight of seed plant^{-1}	Seed yield (kg ha^{-1})	Per cent yield reduction
T_1 : Full Package	82.80	6.18	4.94	1928	-
T_2 : T_1- RDF	71.00	4.88	3.16	1464	24
T_3 : T_1- Weeding	74.59	5.03	3.86	1491	23
T_4 : T_1 - Plant Protection	79.43	5.31	4.26	1574	18
T_5 : T_1- (RDF + Weeding)	58.04	3.57	2.28	982	49
T_6 : T_1- (RDF + Plant Protection)	63.34	4.05	2.54	1023	47
T_7 : T_1- (Weeding + Plant Protection)	69.38	4.43	2.72	1153	40
T_8 :T_1 -(RDF + Weeding +Plant Protection)	50.28	3.13	2.19	933	52
SE +	3.50	0.22	0.21	84	-
C.D. at 5%	10.62	0.66	0.65	255	-
General Mean	68.65	4.57	3.24	1319	36

Conclusion

From the above results it may inferred that adoption of full package of practices was most important for getting higher seed yield production in linseed. Fertilizer was most crucial factor in yield reduction followed by weeding. In combination of two factor RDF + weeding, RDF + plant protection and RDF + weeding + plant protection found to be crucial for reducing linseed yield.

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