Plant Archives Vol. 24, No. 2, 2024 pp. 527-531 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org

DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2024.v24.no.2.074

EFFECT OF NUTRIENTS AND CROP RESIDUE INCORPORATION ON YIELD ATTRIBUTES AND YIELD OF LINSEED

Pallavi Bharti[1], B.K. Agarwal[1], D.K. Shahi[1], S.B. Kumar[1], Ashok Kumar Singh[2], Pragyan Kumari[3], Pankaj Kumar Ray[4] and Meeta Kumari[2]

[1]Department of Soil Science, Birsa Agricultural University, Kanke, Ranchi, India.

[2]Department of Agronomy, Birsa Agricultural University, Kanke, Ranchi, India.

[3]Department of Agrometerology and Environmental Science, Birsa Agricultural University, Kanke, Ranchi, India.

[4]Krishi Vigyan Kendra, Saharsa, Bihar, India.

*Corresponding author E-mail : pallavibhartisbo@gmil.com

(Date of Receiving-24-04-2024; Date of Acceptance-01-07-2024)

ABSTRACT

Crop residue management has become a challenge for current agricultural systems in order to produce enough food to meet the needs of a growing population while maintaining soil health. As a result, increased crop output generates a considerable amount of residue. In order to clean the field, the only option that comes to mind is to burn the residue, believing that it is inexpensive, simple, economical, and takes little time but on the other hand it emits up to 13 tons of CO_2 ha^{-1}, producing severe air, water and soil pollution and the death of beneficial soil invertebrates and microbes. A field experiment was conducted at Research Farm of department of Soil Science, Birsa Agricultural University, Ranchi during rabi season of 2021. The experiment was laid out in a Randomized Block Design (RBD) design with three replications comprising of ten treatments viz., T_1- Farmer's practice 15:20:0::N:P_2O_5:K_2O (Linseed), T_2- 100% RDF (Kg ha^{-1})::60:40:20:20:: N:P_2O_5:K_2O:S (Linseed),T_3- 100% RDF (25% P_2O_5 as residue incorporation+ 75% basal), T_4- 100% RDF + *Trichoderma viride*, T_5- T_3+ *Trichoderma viride* , T_6- 75% RDF, T_7- 75% RDF (25% P_2O_5 as residue incorporation + 75% basal), T_8- 75% RDF + *Trichoderma viride*, T_9- T_7 + *Trichoderma viride* and T_{10}- Control (only crop residue @ 5t ha^{-1} in both the crops), respectively. The crop residue incorporation and nutrient management in linseed influenced the yield attributes and yield of linseed with the highest yield attributing characters and yield achieved with the treatment containing 100% RDF (25% P_2O_5 as residue incorporation + 75% basal) + *Trichoderma viride*, which was at par with 100% RDF N:P_2O_5:K_2O:S (Kg ha^{-1}) ::60:40:20:20 (Linseed).

Key words : Crop residue, Nutrient management, *Trichoderma viride*.

Introduction

Linseed, also known as flax or flaxseed (*Linum usitatissimum* L.), is highly valued among oilseeds due to its versatile uses and unique characteristics. According to El-Nagdy *et al*. (2010), it contains a protein content ranging from 11% to 32% and essential fatty acids, predominantly linoleic acid (omega-6) and alpha-linolenic acid (omega-3, ALA), constituting 30% to 40% of its composition. These essential fatty acids are crucial for human health as they cannot be synthesized by the body and must be obtained from dietary sources. Linseed is also rich in lignans, which have been associated with anticancer properties. Additionally, linseed oil is widely utilized in manufacturing linoleum, oilcloth, waterproof fabrics, paints and varnishes due to its excellent drying properties. The versatile linseed stalk produces valuable fiber known as the "plastic crop," widely used in making paper and plastic products. Furthermore, linseed cake, a byproduct of oil extraction is valued as an excellent fertilizer and animal feed due to its high content of micronutrients, vitamins, dietary fiber, and proteins (up to 38%). In India, linseed is cultivated across 326 thousand hectares of land, with rainfed, irrigated, and utrea-irrigated fields accounting for 63%, 17% and 20% respectively, yielding an average productivity of 533 kg per hectare.

Linseed (*Linum usitatissimum* L.), a significant winter oilseed crop from the Linaceae family (Burako, 2010; Bremer *et al*., 2009), has seen increased cultivation recently, yet research in agronomy and soil science aspects remains limited. National productivity averages for linseed are notably lower compared to global standards. The primary reason for this low productivity is often attributed to inadequate and unbalanced nutrition. Improving linseed productivity requires a strategic approach involving the application of balanced chemical fertilizers, supplemented by crop residues and/or organic manure.

Crop residue management has become a challenge for current agricultural systems in order to produce enough food to meet the needs of a growing population while maintaining soil health. As a result, increased crop output generates a considerable amount of residue, making it harder for the farmer to prepare the same land in a short period of time for the next harvest. In order to clean the field, the only option that comes to mind is to burn the residue, believing that it is inexpensive, simple, economical, and takes little time. When burned, the residue emits up to 13 tons of CO_2 ha^{-1}, producing severe air pollution and the death of beneficial soil invertebrates and microbes. Burning straw releases gaseous pollutants such as CO_2, CH_4, CO, N_2O, NOx, SO_2, Ozone, THC, TC, BTX and a considerable number of particles, all of which have a negative impact on health. During straw burning, total suspended particulate matter (PM25, PM10) levels in the air can reach 100-200 µg m^{-3} in states like Punjab and Haryana in India. Crop residue burning is primarily driven by the short time between harvesting *Kharif* (Rice) and growing *Rabi* (Wheat) crops, labor scarcity, lower industrial demands for crop leftover, and so on (Anuradha *et al*., 2021). Crop residue burning not only pollutes the air and contributes to global climate change, but it also harms soil health by speeding erosion (Thounaojam Thomas Meetei *et al*., 2019). Several greenhouse gases (GHGs), as well as carbonaceous aerosols and particulate matter (PM) are the primary causes of air pollution and the current global climate change. Global concern about some diseases induced by air pollution from the combustion of agricultural crop residue in conjunction with fossil fuels is increasing, leading in a high immature mortality rate. As a result, various scientific communities are concerned about how to manage these agricultural crop wastes. Burning debris on the soil surface degrades soil health since soil is a living entity full of microorganisms. The burning of waste kills bacteria, rendering the soil infertile. Also, many micro and macro nutrients that are volatile in nature are easily lost from the soil as a result of residue burning. As a result, there is an urgent need to identify alternative methods for managing agricultural crop residue after harvest. The only way to prevent the dangerous burning of crop residue is to find alternative methods of managing the residues, such as feeding them to livestock, composting them with farm and vegetable waste, using them as biofuels (making bio-oil and bio-char from the residues) and keeping them in the soil through conservation and conventional tillage.

Thus, a study on "Effect of nutrients and crop residue incorporation on yield attributes and yield of linseed" was carried out at Research farm of the Department of Soil Science, BAU, Ranchi, Jharkhand.

Materials and Methods

The experiment was conducted during rabi 2021 at Research farm of the Department of Soil Science, BAU, Ranchi, Jharkhand (23'17' North, 85'19' East), Ranchi. The field was well-drained medium land and the soil of the experimental site is acidic red loam, slightly acidic in reaction (pH 5.5) with organic carbon (4.30 g kg^{-1}), available P (24.9 kg/ha) and available K (157.4 kg/ha) and available N (197.5 kg/ha), respectively.

The field experiment was laid out in a Randomized Block Design (RBD) with three replications.. Linseed *cv.* 'Divya' was grown in 2021. There were ten treatments comprising of T_1- Farmer's practice 15:20:0::N:P_2O_5:K_2O (Linseed), T_2- 100% RDF (Kg ha^{-1})::60:40:20:20:: N:P_2O_5:K_2O:S (Linseed),T_3- 100% RDF (25% P_2O_5 as residue incorporation+ 75% basal), T_4- 100% RDF + *Trichoderma viride*, T_5- T_3+*Trichoderma viride* , T_6- 75% RDF, T_7- 75% RDF (25% P_2O_5 as residue incorporation + 75% basal), T_8- 75% RDF + *Trichoderma viride*, T_9- T_7 + *Trichoderma viride* and T_{10}- Control (only crop residue @ 5t ha^{-1} in both the crops), respectively.

For linseed, field preparation was done with cultivator to get a fine tilth. The crop was sown in rows 30 cm apart and in continuous pattern with a seed rate of 25 kg/ ha. The recommended dose of nitrogen (60 kg N/ha), phosphate (40 kg P_2O_5/ha), potash (20 kg K_2O/ha) and sulphur (20 kg S/ha) was applied at the time of sowing.

Linseed crop was harvested manually by uprooting the plants from the net plot area. After 3-4 days of sun drying, threshing was done by beating against a wooden stick and sieving was done to clean the seeds. Seed and stover yields were recorded and converted to q/ha basis. After cleaning and drying the grain yield was recorded and reported at 12% moisture content. Straw yield was obtained by subtracting grain yield from total biological yield and both were expressed in q/ha. Biological yield was calculated by adding the grain yield and straw yield and it is also expressed in q/ha. While the harvest index was calculated by the formula:

$$\text{Harvest Index (\%)} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

All collected data were analyzed with the help of analysis of variance (ANOVA) technique for randomized block design. The treatment variations were tested for significance. The standard error of mean SE (m) ± and critical difference (CD) at 5% probability level were calculated (Gomez and Gomez, 1984).

Results and Discussion

Yield attributes of linseed

Number of branch/ plant

Perusal of data on number of branch/plant in Table 1 reveals that the nutrient and crop residue incorporation in linseed influenced the number of branches of linseed plant. The combined effect of nutrients and crop residue incorporation on linseed resulted in the highest number of branches/plant of linseed crop (7.68) with treatment T_5- 100% RDF (25% P_2O_5 as residue incorporation+ 75% basal)+*Trichoderma viride*, which was at par with 100% RDF N:P_2O_5:K_2O:S (Kg ha^{-1})::60:40:20:20 (Linseed) (6.87), 100% RDF+ *Trichoderma viride* (6.73), 75% RDF + *Trichoderma viride* (6.77) and 75% RDF (25% P_2O_5 as residue incorporation + 75% basal) + *Trichoderma viride* (7.40). This has conformity with Mandal *et al*. (2004).

Number of capsule/ plant

Data on capsule/ plant given in Table 1 indicate that nutrient management practices and crop residue incorporation did influence the capsule/plant of linseed crop. The cumulative effect of crop residue incorporation and nutrient management practices on linseed resulted in the highest number of capsule/plant of linseed crop (29.9) with treatment containing 100% RDF (25% P_2O_5 as residue incorporation+ 75% basal)+*Trichoderma viride* , which was at par with 100% RDF N:P_2O_5:K_2O:S (Kg ha^{-1})::60:40:20:20 (Linseed) (28.1), 100% RDF+ *Trichoderma viride* (27.4) and 75% RDF (25% P_2O_5 as residue incorporation + 75% basal) + *Trichoderma viride* (23.8). Utilizing crop residues additionally decreased soil moisture evaporation, upheld soil temperature, and preserved soil structure, consequently enhancing seed emergence (Singh, 2009) and creating optimal conditions for plant growth and development. Ravi *et al*. (2019) similarly discovered that applying crop residues alongside recommended doses of fertilizers significantly boosted the number of branches per plant, pods per plant, seed index, as well as haulm and seed yield of soybean. Managing crop residues is a widely acknowledged and effective approach for maintaining the physical, chemical and biological functions of soil. Crop residues contribute to soil fertility by releasing vital plant nutrients, enhancing soil organic matter content, improving aeration and porosity, reducing soil bulk density, and maintaining soil moisture levels. These favorable conditions promote robust plant growth, leading to enhanced photosynthesis, increased accumulation of photosynthates, greater branching, more capsule per plant, more seeds per capsule and ultimately higher yields of both grain and straw.

Number of seed/ capsule

Data on seed/capsule given in Table 1 indicate that nutrient management practices and crop residue incorporation did influence the seed/capsule of linseed crop. The cumulative effect of crop residue incorporation and nutrient management practices on linseed resulted in the highest number of capsule/plant of linseed crop (7.17) with treatment containing 100% RDF (25% P_2O_5 as residue incorporation+ 75% basal) + *Trichoderma viride*, which was at par with rest all the treatments except farmer's practice (T_1). Using balanced NPK as a chemical fertilizer or incorporating crop residues alongside *Trichoderma viride* resulted in higher values of yield attributes in linseed, attributed to improved nutrition. These findings regarding yield attributes align well with the research conducted by Mandal *et al*. (2004). It was observed that when managing crop residues, integrating them into the soil proved to be the most effective treatment compared to other methods within the same nutrient management regimen.

1000 grain weight : Varied methods of crop residue incorporation and nutrient management practices in linseed were found to be at par with each other with higher test weight in treatment having 100% RDF (25% P_2O_5 as residue incorporation+ 75% basal)+ *Trichoderma viride* (7.72 g) the results are found to be in close conformity with Ravi *et al*. (2019).

Yields

It is evident from the data presented in Table 1 that the seed yield of linseed crop was affected by crop residue incorporation and nutrient management. Furthermore, 100% RDF (25% P_2O_5 as residue incorporation+ 75% basal) + *Trichoderma viride* had a higher effect on seed yield of linseed crop (18.1 q/ha) and was at par with 100% RDF N:P_2O_5:K_2O:S (Kg ha^{-1})::60:40:20:20 (Linseed), 75% RDF + *Trichoderma viride* and 75% RDF (25% P_2O_5 as residue incorporation + 75% basal)

Table 1 : Effect of nutrient and crop residue incorporation on yield attributing characters of linseed during 2021-22.

Treatments	No. of branches per plant	No. of capsule per plant	No. of seed per capsule	1000 grain weight
T_1	5.07	21.3	6.03	6.30
T_2	6.87	28.1	6.97	7.47
T_3	5.63	25.8	6.77	7.23
T_4	6.73	27.4	6.90	7.33
T_5	7.68	29.9	7.17	7.72
T_6	5.80	25.9	6.73	7.10
T_7	5.53	23.8	6.57	6.97
T_8	6.77	25.2	6.83	7.30
T_9	7.40	28.9	7.04	7.63
T_{10}	5.17	24.8	6.30	6.93
SEm±	0.35	1.31	0.30	0.18
CD (P=0.05)	1.04	3.88	0.90	0.53
CV (%)	9.67	8.67	7.82	4.28

Treatment Details : T_1- Farmer's practice $N:P_2O_5:K_2O$ (Kg ha^{-1}) :: 15:20:0 (Linseed), T_2 - 100% RDF $N:P_2O_5:K_2O:S$ (Kg ha^{-1})::60:40:20:20 (Linseed), T_3 - 100% RDF (25% P_2O_5 as residue incorporation+ 75% basal), T_4 - 100% RDF+ *Trichoderma viride*, T_5 - T_3+*Trichoderma viride*, T_6 - 75% RDF, T_7 - 75% RDF (25% P_2O_5 as residue incorporation + 75% basal), T_8 - 75% RDF + *Trichoderma viride*, T_9 - T_7 + *Trichoderma viride*, T_{10} - Control (only crop residue @ 5t ha^{-1} in both the crops).

Table -2 : Effect of nutrient and crop residue incorporation and on grain yield (q ha^{-1}), straw yield (q ha^{-1}), biological yield (q ha^{-1}) and harvest index (%) in linseed.

Treatments	Grain Yield	Straw Yield	Biological Yield	Harvest Index
T_1	12.2	30.6	42.8	28.5
T_2	16.4	34.4	50.8	32.3
T_3	15.1	34.3	49.4	30.6
T_4	16.2	32.9	49.1	33.5
T_5	18.1	36.0	54.1	33.5
T_6	15.0	28.7	43.7	34.2
T_7	14.0	28.2	42.2	33.2
T_8	15.4	30.2	45.6	34.0
T_9	16.8	34.6	51.4	32.9
T_{10}	13.9	29.2	43.1	32.8
SEm±	0.96	2.17	2.02	2.46
CD (P=0.05)	2.85	6.46	6.00	7.31
CV (%)	10.8	11.8	7.41	13.1

Treatment Details : T_1- Farmer's practice $N:P_2O_5:K_2O$ (Kg ha^{-1}) :: 15:20:0 (Linseed), T_2 - 100% RDF $N:P_2O_5:K_2O:S$ (Kg ha^{-1})::60:40:20:20 (Linseed), T_3 - 100% RDF (25% P_2O_5 as residue incorporation+ 75% basal), T_4 - 100% RDF+ *Trichoderma viride*, T_5 - T_3+*Trichoderma viride*, T_6 - 75% RDF, T_7 - 75% RDF (25% P_2O_5 as residue incorporation + 75% basal), T_8 - 75% RDF + *Trichoderma viride*, T_9 - T_7 + *Trichoderma viride*, T_{10} - Control (only crop residue @ 5t ha^{-1} in both the crops).

+ *Trichoderma viride* and T_1- Farmer's practice $N:P_2O_5:K_2O$ (Kg ha^{-1}) :: 15:20:0 (Linseed) (12.2 q/ha) which was found to be lowest. In line with the seed yield, stalk yield of linseed crop was affected by the nutrient and crop residue management options. 100% RDF (25% P_2O_5 as residue incorporation+ 75% basal) + *Trichoderma viride* impacted highly the linseed stalk yield producing the highest quantity of stalk (36.0 q/ha) as compared to 100% RDF $N:P_2O_5:K_2O:S$ (Kg ha^{-1})::60:40:20:20 (Linseed) , which in turn were at par with par with 100% RDF (25% P_2O_5 as residue incorporation+ 75% basal), 75% RDF + *Trichoderma viride* and 75% RDF (25% P_2O_5 as residue incorporation + 75% basal) + *Trichoderma viride*. Incorporating crop residue alongside the recommended NPKS (100% NPKS) for each crop led to increased grain yield in linseed compared to solely applying 100% NPKS. While chemical fertilizers alone boosted linseed grain yield significantly, combining crop residues with chemical fertilizers further enhanced this yield. The combined application ensured synchronized nutrient availability in the soil, facilitating increased nutrient absorption by plants, which promoted root elongation, root development, and ultimately, the growth and yield of linseed. Sole application of crop residues was not deemed an effective nutrient management practice for optimizing linseed grain yield. Consistently integrating crop residue with sufficient NPKS significantly enhanced linseed grain yield compared to other treatments. Prolonged retention of residue enhances soil microbial diversity and biomass, facilitates nutrient recycling, boosts soil organic matter content (Liu *et al*., 2011), enhances soil quality, establishes a conducive soil environment for root growth, and ultimately leads to increased crop yields (Zhao and Chen, 2008a; Zhou *et al*., 2008).

Biological yield : The biological yield of linseed crop was worked out for different treatments and presented in Table 2. The biological yield of linseed crop was found to be highest with 100% RDF (25% P_2O_5 as residue incorporation+ 75% basal)+*Trichoderma viride* (54.1 q/ ha) was at par with 100% RDF $N:P_2O_5:K_2O:S$ (Kg ha^{-1})::60:40:20:20 (Linseed), 100% RDF (25% P_2O_5 as residue incorporation + 75% basal), 100% RDF+ *Trichoderma viride* and 75% RDF (25% P_2O_5 as residue incorporation + 75% basal) + *Trichoderma viride* (Zhou *et al*., 2008).

Harvest Index : The harvest index of linseed crop was worked out for different treatments and presented in Table 2. The harvest index of linseed crop was crop residue incorporation and nutrient management in linseed where all the treatments were containing crop residues were significantly at par with each other (Zhou *et al*., 2008).

Conclusion

Among all the crop residue incorporation and nutrient management practices in the linseed crop, 100% RDF (25% P_2O_5 as residue incorporation+ 75% basal)+ *Trichoderma viride* influenced the yield attributes more effectively indicating the effect crop residue incorporation and nutrient management along with 100% 100% RDF $N:P_2O_5:K_2O:S$ (Kg ha^{-1})::60:40:20:20 (Linseed).

Conflicts of interest

The authors state that they have no known financial conflicts of interest or personal ties that might have appeared to have an impact on the work described in this study.

References

Anuradha Kadian, K.S. and Meena M.S. (2021). Reasons and awareness levels of farmers on residue burning in Indo-Gangetic Plain of India: An exploratory research. *J. Agri Search*, **8(1)**, 62- 66.

Bremer, B. and Bremer Kiche M. (2009). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants, APGIII. *Botanical J. Linnaean Soc*., **161**, 105- 121.

Burako, L. (2020). Genetic diversity study of linseed genotypes on acidic soil at bedi trial site, central highland of Ethiopia (*Master thesis*, Addis Ababa University, Addis Ababa).

El-Nagdy, G.A., Dalia M.A., Nassar Eman, A. El-Kady and Gelan S.A. El-Yamanee (2010). Response of flax plant (*Linum usitatissimum* L.) to treatments with mineral and bio-fertilizers from nitrogen and phosphorus. *J. Amer. Sci.*, **6(10)**, 207-217.

Liu, D.H., Shu L., Chen Q., Chen S.H., Chen H.L. and Zhu Z.L. (2011). Effects of straw mulching and little- or zero-tillage on microbial diversity and biomass C and N of alluvial soil in Chengdu Plain, China. *Chin J Appl Environ Biol*., **17**, 158–161. (in Chinese with English abstract)

Meetei, Thounaojam Thomas, Kundu M.C. and Devi Yumnam Bijilaxmi, Kumari Nirmala and Sapam Rajeshkumar (2019). Soil Organic Carbon Responses under different Forest Cover of Manipur. A Review. *Int. J. Curr. Microbiol. App. Sci*. **8(2)**, 2634-2641. doi: https://doi.org/10.20546/ijcmas.2019.802.308

Mandal, K.G., Misra A.K., Hati K.M., Bandyopadhyay K.K., Ghosh P.K. and Manoranjan M. (2004). Rice residue - management options and effects on soil properties and crop productivity. *J. Food, Agricult. Environ.*, **2(1)**, 224-231.

Ravi, S., Jadhav R.L., Bhat S.N. and Kamble Anand (2019). Effect of plant residues on growth and seed yield of soybean. *Int. J. Curr. Microbiol. Appl. Sci.*, **8(04)**, 490-495.

Singh, G. (2009). Effects of wheat straw and farmyard manure mulches on overcoming crust effect, improving emergence, growth and yield of soybean and reducing dry matter of weeds. *Int. J. Agricult. Res.*, **4**, 418-424.

Zhao, P. and Chen F. (2008a). Effects of straw mulching plus nitrogen fertilizer on nitrogen efficiency and grain yield in winter wheat. *Acta Agron Sin*, **34**, 1014–1018.

Zhao, G.D. (2008). The growth and declining of soil microbe amount in root zone and their influence to the plant re-plantation in the apple orchard of Loess Plateau [*M.S. thesis*], Northwest University of Science and Technology (Chinese).