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ASSESSMENT OF LINSEED PRODUCTION UNDER SOLID-LIQUID ORGANIC SOURCE FOR SUSTAINABLE AGRICULTURE IN JHARKHAND REGION OF INDIA

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ABSTRACT

A field experiment was conducted during *rabi* season of 2021-22 and 2022-23 at Research Farm of Birsa Agricultural University, Kanke, Ranchi, Jharkhand to study the "Assessment of Linseed Production under Solid-Liquid Organic Source for Sustainable Agriculture in Jharkhand Region of India". The treatments comprised of nine organic manure combinations with control *viz.*, T_1- = FYM 33% RDN, T_2- Neemcake 33% RDN, T_3- T_1 +T_2, T_4- T_1+ 10% vermiwash at B, F, C, T_5- T_2+10% vermiwash at B, F, C, T_6- T_3+10% vermiwash at B, F, C, T_7- T_1+2.5% Cow urine at B, F, C, T_8- T_2+2.5% Cow urine at B, F, C, T_9- T_3+2.5% Cow urine at B, F, C and T_{10}- Absolute control, and were replicated thrice. Pooled analysis revealed that T_6 - T_3+10% Vermiwash at B, F, C resulted in maximum plant stand at 15 DAS (99.03/m^2), capsules per plant (28.49), seeds per capsule (8.30), test weight (7.96 g), seed yield (14.14 q/ha), straw yield (30.00 q/ha), gross return (77265.95 ` /ha), net return (53900.95` /ha), and b:c ratio (2.31), which was at par with T_9 = T_3+2.5% Cow urine at B, F, C (plant stand at 15 DAS 96.52 /m^2, capsules per plant 26.23, seeds per capsule 8.01, test weight 7.93 g, seed yield (13.16 q/ha), straw yield 28.74 q/ha, gross return 72022.69 ` /ha, net return 49257.69 ` /ha and b:c ratio 2.16).

Key words : Linseed, FYM, Neem cake, Vermiwash, Yield, Economics.

Introduction

Among all the oilseeds, linseed [*Linum usitatissimum* (L.)] is more important because of its many applications and unique characteristics. The species linseed (*Linum usitatissimum* L.) is a member of the tribe Lineae, family Linaceae, and order Malpighiales. In terms of cultivation and seed output, it ranks second in importance among *rabi* oilseed crops in India, after rapeseed-mustard. There are over 230 species in the genus Linum is, but the only economically significant species is cultivated linseed, which is also among the earliest plants to be cultivated for oil and fibre (Tadesse *et al*., 2010). It has a high moisture content of 7.7%, 3.3% ashes, 20% protein, 41% oil, and 28% nutritional fibre. It contains a high proportion of essential fatty acids (75%), polyunsaturated fatty acids (75%), omega-3 fatty acid alpha-linolenic acid (57%), and omega-6 fatty acid linoleic acid (16%) (Morris 2005).

Linseed occupies an area of 32.23 lakh ha yielding 30.68 lakh tonnes with an average productivity of 952 kg/ha in the world whereas in India, it occupies an area of 1.7 lakh ha with a production and productivity of about 1 lakh tonnes and 574 kg/ha, respectively (AICRP-Linseed, 2018). In case of Jharkhand, area under linseed is 25000 ha with production of 143 MT and productivity of 4.89 q/ha (ICAR-ATARI, 2016-17).

Nowadays, linseed is becoming more and more popular as a functional meal. Medical study has recently revealed that linseed is the best natural source of lignan and Omega-3 fatty acid (α-linolenic acid), which have enormous nutritional and therapeutic effects on the human body system (Toureì and Xueming, 2010). Furthermore, linseed has significant levels of other nutrients that are good for us, like proteins, vitamins, minerals, soluble and insoluble fibre, and complete carbs (Genser and Morris, 2003). Conventional farming methods that boost crop output also cause environmental damage, threats to human health and deterioration of the soil. Finding safer, more sustainable and financially feasible alternatives to inorganic agriculture is necessary in light of the negative impacts of its careless application.

Jharkhand's soil is also suitable for the cultivation of crop likeLinseed and it is a low-nutrient crop that works well with organic farming methods. Organic farming is an alternative production method, which eschews or minimises the use of artificial fertilisers, pesticides, growth regulators and additives in animal feed. vermicompost, FYM, vermiwash, biofertilizers, and other organic manures—both solid and liquid—are utilised in organic farming (Stockdale *et al*., 2001; Alabadan *et al*., 2009). Use of organics in crop production is gaining much popularity. Organic sources like FYM and vermicompost *etc.* supply not only organic matter but also increase the fertility status of the soil (Chung *et al*., 2000; Keupper and Gegner, 2004).Organic manure enhances and maintains soil organic carbon status for sustained crop yield and also India blessed with rich natural heritage of soil, climate and biodiversity has a vast potential for organic farming (Debashis Dash and Amardeep, 2018). The status of organic carbon increases by the application of organic manures. The organic manure releases nutrient slowly and has good effect on instant crop as well as performance of succeeding crops. It also maintains the soil physical, chemical and biological characteristics and improves overall ecological balance of the crop production system.

Keeping this in view, the overall objectives of the field experiment is to evaluate and select suitable organic source for sustainable linseed production in Jharkhand region.

Materials and Methods

A field experiment was conducted in upland areas of Research Farm of the Birsa Agricultural University, Kanke, Ranchi (23º17' N latitude, 85º10' E longitude and 625 m above mean sea level), India, during *rabi* seasons of 2021-22 and 2022-23 respectively to evaluate the "Assessment of Linseed Production under Solid-Liquid Organic Source for Sustainable Agriculture in Jharkhand Region". Variety of linseed taken for experimentation was "Divya". The experiment was laid out in Randomized Block Design with ten treatments comprising of solid-liquid organic sources *viz*., T_1- = FYM 33% RDN, T_2- Neemcake 33% RDN, T_3- T_1 +T_2, T_4- T_1+ 10% vermiwash at B, F, C, T_5- T2+10% vermiwash at B, F, C, T_6- T_3+10% vermiwash at B, F, C, T_7- T_1+2.5% Cow urine at B, F, C, T_8- T_2+2.5% Cow urine at B, F, C, T_9- T_3+2.5% Cow urine at B, F, C and T_{10}- Absolute control and were replicated thrice. Soil of the experimental plot was sandy loam in texture having low carbon (0.34%) and nitrogen (178.6 Kg/ha) and medium in phosphorous (15.23 Kg/ha) and potassium (184.64 Kg/ha), slightly acidic in nature (pH 5.6). Size of experimental plot was 5 m × 3 m. The mean minimum and maximum temperature throughout the cropping season ranged from 2.2ºC to 38.1ºC, respectively during 2021-22, while during 2022-23 the mean minimum and maximum temperature ranged from 2.0ºC to 37.6ºC, respectively. Total rainfall recorded during crop period was 66.80 mm in first year and 393.90 mm in second year of experimentation. The recommended fertilizer dose applied was 80 kg N: 40 kg P_2O_5: 20 kg K_2O /ha supplied through FYM, neem cake, vermiwash and cow urine. Linseed was sown manually in rows by using 30 kg/ha seed rate with 30 cm row spacing. The recommended package of practices was applied to all the treatments. All observation on yield attributes (no. of capsules per plant, no. of seeds per capsule and thousand seed weight) and yield (seed yield and stalk yield) and economics were recorded from the marked area of net plot.

The methodology adopted for calculating yield attributes, yields and economics of linseed are as follows: number of capsules per plant were recorded from five randomly tagged plants and mean was worked out by dividing the total number of capsules by five and used for statistical analysis. Ten capsules were selected from the bunch of five tagged plants, number of seeds were counted and average was worked out. Same quantity of the harvested grains from each net plot was dried in an oven at 60°C for 20-24 hours to get constant weight. One thousand seeds were taken from produce of each treatment, weighed and expressed as 1000-seed weight in grams. The seeds were weighed on an electronic balance. Foe seed yield, after complete sun drying the seed weight of each net plot was measured on physical top balance and converted to quintal/hectare. The results were expressed on a 14 percent moisture basis. In case of straw yield, after harvesting of the crop, sun dried in the field and the produce was tied in to bundles. Stalk yield of plot was noted down after subtraction of seed yield from bundle weight. Then the bundle weight of the stalk (kg/plot) was taken and stalk yield is expressed in q/ha.

In preparing the cost of cultivation (` /ha), all the expenditures incurred on items such as labour (including family labour), seeds, chemicals (fertilizers and pesticides) and power (tractor, power tiller and pumping water) were summed up. Cost of cultivation for each treatment was calculated separately. Gross return was calculated by multiplying the yields (of both main and by-product) with the prevailing market prices and was expressed as ` /ha. Net return (`/ha) was measured by deducting the cost of cultivation from gross return.

To estimate the benefit cost ratio, it was derived from diving net return by cost of cultivation.

All the data obtained from the experiments were put to statistical analysis by adopting appropriate method of "Analysis of Variance" as suggested by the Gomez and Gomez (1976). Critical difference (CD) at 5% level of significance was worked out to determine the difference between treatments.

Results and Discussion

Effect of solid-liquid organic sourceson yield attributes of linseed

Yield attributing characters that determine the yield is the resultant of the vegetative development of the plant. Analysis of pooled data showed that all yield attributing characters *viz*., no. of capsule per plant, no. of seeds per capsule and thousand seed weight were significantly influenced by organic sources (Table 1).

A close inspection of data revealed that number of capsules per plant was found significantly maximum in T_6=T_3+10% Vermiwash at B, F, C (28.49), which was significantly superior over T_1= FYM 33% RDN (22.92), T_2 = Neem cake 33% RDN (24.33), T_7=T_1+2.5% Cow urine at B, F, C (23.71), T_8 = T_2+2.5% Cow urine at B, F, C (24.23) and T_{10} = Absolute control (20.97), but at par with rest of the treatments.

Statistically higher seeds per capsule was observed in T_6=T_3+10% Vermiwash at B, F, C (8.7), which was significantly superior over T_1= FYM 33% RDN (6.3), T_7=T_1+2.5% Cow urine at B, F, C (7.6) and T_{10}=Absolute control (7.4) however, at par with rest of the treatments.

It is evident from the data that test weight was non-statistically affected by different organic sources. Test weight was also recorded maximum in T_6=T_3+10% Vermiwash at B, F, C (7.96) and minimum in T_{10}=Absolute control (7.49).

Neem cake can be adduced to better availability and uptake of the nutrients, which might have led to the balanced C/N ratio and increased plant metabolism (Emura and Hosoya, 1979). Also neem seed cake contains 2-5% nitrogen, 0.5 – 1% phosphorus, 1-2% K, 0.3 – 1% Mg 0.5 – 3% Ca (Radwanksi and Wickens, 1981). The incorporation of neem seed cake has the tendency of increasing the micronutrient content of the soil as most organic manures. The application of FYM does maintain not only soil health, but also provide nutrients for long time due to its slow mineralization (Hussain *et al*., 2017). The vermiwash also contains enzymes and secretions of earthworms and would stimulate the growth and yield of crops (Samadhiya *et al*., 2013). Due to all these reasons, vermiwash when mixed with FYM and neem cake increased the capsule per plant and seed per capsule in treatment T_6=T_3+10% Vermiwash at B, F, C. These findings have conformity with Singh *et al*. (2023).

Effect of solid-liquid organic sources on yields of linseed

The yield in any crop is dependent upon the photosynthetic source it can build up. A sound source in terms of growth parameters to support and hold the leaves are logically able to increase the total dry matter and

Table 1 : Effect of solid-liquid organic source on yield attributes of linseed.

Treatments	Capsule/plant			Seed/capsule			Test weight		
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
T_1= FYM 33% RDN	22.54	23.26	22.92	6.01	6.56	6.3	7.50	7.68	7.59
T_2=NEEM CAKE 33 % RDN	23.97	24.66	24.33	7.98	8.53	8.3	7.59	7.76	7.68
T_3= T_1 + T_2	24.44	25.13	24.78	8.21	8.76	8.5	7.60	7.77	7.68
T_4=T_1+ 10% VERMIWASH at B, F, C	24.76	25.42	25.01	7.95	8.50	8.2	7.70	7.86	7.78
T_5=T_2+10% VERMIWASH at B, F, C	25.81	26.47	26.17	7.58	8.13	7.9	7.70	7.86	7.78
T_6=T_3+10% VERMIWASH at B, F, C	28.08	28.69	28.49	8.38	8.93	8.7	7.89	8.03	7.96
T_7=T_1+2.5% Cow urine at B, F, C	23.43	24.14	23.71	7.31	7.86	7.6	7.55	7.73	7.64
T_8=T_2+2.5% Cow urine at B, F, C	23.80	24.51	24.23	8.08	8.63	8.4	7.55	7.73	7.64
T_9= T_3+2.5% Cow urine at B, F, C	25.95	26.58	26.23	8.23	8.78	8.5	7.86	8.01	7.93
T_{10}=Absolute control	20.64	21.39	20.97	7.11	7.66	7.4	7.40	7.59	7.49
SEm±	1.376	1.349	1.362	0.31	0.31	0.31	0.260	0.256	0.258
CD (P=0.05)	4.087	4.007	4.046	0.97	0.97	0.97	0.773	0.762	0.767
CV%	9.788	9.334	9.555	7.00	6.53	6.76	5.906	5.693	5.797

Table 2 : Effect of organic manures on yields of linseed.

Treatments	Seed Yield (q/ha)			Stover Yield (q/ha)			Harvest Index (%)		
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
T_1= FYM 33% RDN	10.47	11.10	10.79	20.42	26.64	23.53	33.83	29.39	31.61
T_2=NEEM CAKE 33 % RDN	11.94	12.41	12.18	24.78	27.92	26.35	32.47	30.75	31.61
T_3= T_1 +T_2	12.03	12.61	12.32	25.11	28.16	26.64	32.40	31.12	31.76
T_4=T_1+ 10% VERMIWASH at B, F, C	12.19	12.82	12.50	26.83	28.38	27.61	31.33	31.10	31.21
T_5=T_2+10% VERMIWASH at B, F, C	12.63	13.23	12.93	27.34	28.55	27.95	32.19	31.61	31.90
T_6=T_3+10% VERMIWASH at B, F, C	13.80	14.49	14.14	29.64	30.36	30.00	31.82	32.25	32.03
T_7=T_1+2.5% Cow urine at B, F, C	10.99	11.48	11.24	21.15	27.12	24.13	34.22	29.72	31.97
T_8=T_2+2.5% Cow urine at B, F, C	11.10	11.73	11.41	23.86	27.48	25.67	32.54	30.02	31.28
T_9= T_3+2.5% Cow urine at B, F, C	12.91	13.41	13.16	28.60	28.87	28.74	31.16	31.71	31.43
T_{10} =Absolute control	7.76	8.35	8.06	19.13	20.14	19.64	29.14	29.27	29.21
SEm±	0.56	0.66	0.45	2.16	1.21	1.02	1.84	1.29	0.96
CD (P=0.05)	1.76	2.07	1.39	6.72	3.77	3.17	5.72	4.03	3.00
CV%	8.43	9.47	8.95	15.15	7.66	11.41	9.91	7.30	8.61

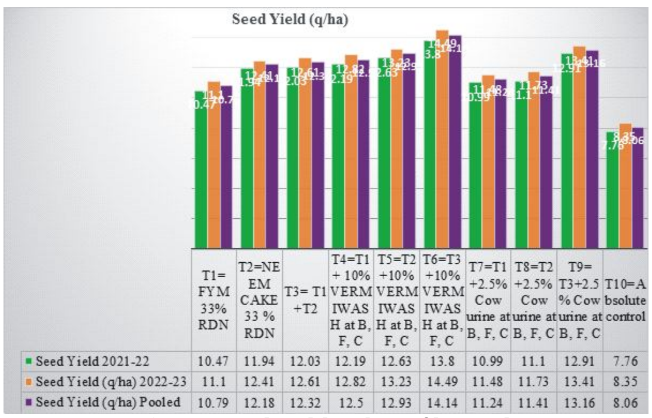

Fig. 1 : Seed yield (q/ha) of linseed.

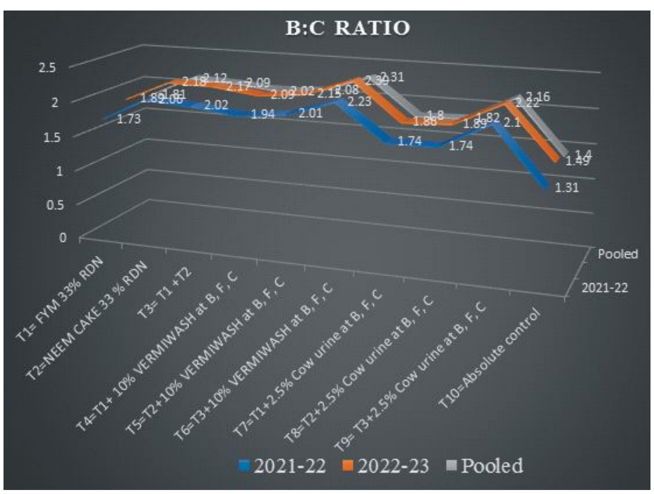

Fig. 2 : B:C Ratio of linseed.

later lead to higher seed yield. Partitioning of dry matter production and its distribution in different plant parts is important for determination of total yield of crop (Donald, 1962).

Close examination of pooled data regarding yields have been shown in Table 2 and Fig. 1. Seed and stover yields were significantly influenced by different solid-liquid organic sources.

An appraisal of data revealed that T_6=T_3+10% Vermiwash at B, F, C recorded with significantly higher seed yield(14.14q/ha) but comparable to T_5=T_2+10% Vermiwash at B, F, C (12.93 q/ha) and T_9= T_3+2.5% Cow urine at B, F, C (13.16 q/ha) whereas, statistically superior to rest of the treatments.

Scanning of data revealed that T_6=T_3+10% Vermiwash at B, F, C resulted in significantly higher stover yield (30.00 q/ha) which was at par with T_4=T_1+ 10% Vermiwash at B, F, C (27.61 q/ha), T_5=T_2+10% Vermiwash at B, F, C (27.95 q/ha) and T_9= T_3+2.5% Cow urine at B, F, C (28.74 q/ha) while significantly superior over rest of the treatments.

Data presented in Table 2 indicated that harvest index was not influenced by different organic sources. However, highest harvest index at was observed in treatment T_6=T_3+10% Vermiwash at B, F, C (32.03%) while lowest in T_{10}=Absolute control (29.21%).

Best performance of treatment T_6=T_3+10% Vermiwash at B, F, C might be due to increased yield attributes in this treatment. Increased seed and stover yield can also be result of the effect of adequate availability of nitrogen, phosphorus and potassium in soil solution to accelerate root growth and more uptakes of nutrients. Higher yield is also due to improved micro – environmental conditions, especially the activities of soil micro – organisms involved in nutrient transformation and fixation. Zambare *et al*. (2008) conclude that vermiwash contains various enzymes cocktail of protease, amylase urease and phosphatase and also Microbial study of

Table 3 : Effect of organic manures on economics of linseed.

Treatments	Cost of Cultivation (`/ha)	Gross Return (` /ha)			Net Return (` /ha)			B:C Ratio		
		2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
T_1 = FYM 33% RDN	21240	57966.51	61362.91	59664.71	36726.51	40122.91	38424.71	1.73	1.89	1.81
T_2 =NEEM CAKE 33 % RDN	21465	65617.01	68180.07	66898.54	44152.01	46715.07	45433.54	2.06	2.18	2.12
$T_3 = T_1 + T_2$	21865	66110.47	69223.53	67667.00	44245.47	47358.53	45802.00	2.02	2.17	2.09
$T_4=T_1$+ 10% VERMIWASH at B, F, C	22740	66929.23	70325.63	68627.43	44189.23	47585.63	45887.43	1.94	2.09	2.02
$T_5=T_2$+10% VERMIWASH at B, F, C	22965	69186.41	72416.15	70801.28	46221.41	49451.15	47836.28	2.01	2.15	2.08
$T_6=T_3$+10% VERMIWASH at B, F, C	23365	75398.42	79133.49	77265.95	52033.42	55768.49	53900.95	2.23	2.39	2.31
$T_7=T_1$+2.5% Cow urine at B, F, C	22140	60748.11	63387.85	62067.98	38608.11	41247.85	39927.98	1.74	1.86	1.80
$T_8=T_2$+2.5% Cow urine at B, F, C	22365	61285.43	64681.83	62983.63	38920.43	42316.83	40618.63	1.74	1.89	1.82
$T_9=T_3$+2.5% Cow urine at B, F, C	22765	70666.15	73379.22	72022.69	47901.15	50614.22	49257.69	2.10	2.22	2.16
T_{10}=Absolute control	18580	42976.95	46198.35	44587.65	24396.95	27618.35	26007.65	1.31	1.49	1.40
SEm±		2753.83	3393.78	2220.06	2753.83	3393.78	2220.06	0.13	0.15	0.10
CD (P=0.05)		8571.80	10563.75	6910.36	8571.80	10563.75	6910.36	0.39	0.48	0.31
CV%		7.49	8.80	8.15	11.43	13.10	8.88	11.63	13.03	8.81

• **Note:** Selling price of linseed grain = 5000 /- `/q • **Note:** Selling price of linseed straw = 220 /- `/q

vermiwash found that nitrogen fixing bacteria like *Azotobacter* sp., *Agrobacterium* sp. and *Rhizobium* sp. and some phosphate solublizing bacteria.

Effect of solid-liquid organic sources on economics of linseed

Solid-liquid organic sources clearly influenced the economic indicators *i.e.* gross return, net return and b:c ratio of linseed (Table 3 and Fig. 2). $T_6=T_3$+10% Vermiwash at B, F, C significantly exhibited the maximum gross and net return (Rs. 77265.95 ` /ha /- and 53900.95 ` /ha /- respectively), which was at par with $T_5=T_2$+10% Vermiwash at B, F, C(Rs. 70801.28 ` /ha /- and 47836.28 ` /ha/-, respectively) and $T_9= T_3$+2.5% Cow urine at B, F, C (Rs 72022.69 ` /ha /- and 49257.69 ` /ha/-, respectively), while statistically superior over rest of the treatments.

In case of b:c ratio, it was also reported significantly highest in $T_6=T_3$+10% Vermiwash at B, F, C (2.31) which was statistically superior over T_1= FYM 33% RDN (1.81), $T_7=T_1$+2.5% Cow urine at B, F, C (1.80), $T_8=T_2$+2.5% Cow urine at B, F, C (1.82) and T_{10}=Absolute control (1.40) while, comparable to rest of the treatments.

The reason behind increased gross return, net return and B:C ratio in $T_6=T_3$+10% Vermiwash at B, F, C was due to highest grain and straw yield. Application of vermiwash along with FYM and neem cake helped in producing higher biomass and also in better recovery of N, P and K in the plant. Similar effects have also been observed by Trivedi and Bhatt (2006). These findings are parallel with the findings of Kumar *et al*. (2022) and Singh *et al*. (2023).

Conclusion

This study indicated that FYM + neem cake + vermiwash have a potential source of plant nutrients, beneficial micro-organisms and enzymes. In this regard, treatment (T_6) containing these organic sources are the best among other combinations of organic sources which showing optimum seed yield (14.14 q/ha), gross return (Rs. 77265.95 `/ha/-), net return (Rs. 53900.95 `/ha/-) and B:C ratio (2.31). It can also be conclude from the study that the combinations prove to be an effective organic source in Ranchi district of Jharkhand region which contributes the increased growth of crop when applied to it. Thus vermiwash along with FYM and neem cake can be used as a substituent of commercial fertilizers available in market.

Conflict of interest : The authors declare that the research was conducted in the absence of any potential conflict of interest.

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References

Alabadan, B.A., Adeoye, P.A. and Folorunso E.A. (2009). Effect of different poultry wastes on physical, chemical and biological properties of soil. *Caspian J. Environ. Sci*., **7(1)**, 31-35.

All India Coordinated Research Project on Linseed (2018).

Chung, R.C.H., Wang Y., Wang R.S., Wang C.W., Wang Y.T. and Wang (2000). Influence of organic matter and inorganic fertilizer on the growth and nitrogen accumulation of corn plants. *Taiwan J. Plant Nutr*., **23(3)**, 297-311.

Debashis, D. and Amardeep (2018). A review on Organic Farming as a Potential Sector of Agripreneurship Development among the Tribal Youth of India. *Int. J. Agricult., Environ. Biotech*., **11(5)**, 761-767.

Donald, G.M. (1962). In search of yield. *J. Aust. Inst. Agricult. Sci*., **28**, 1971-1978.

Emura, K. and Hosoya T. (1979). Effect of fertilization on the quality and yield of spring sown carrots. *Bulletin of the Saitama Horticultural Experimental Station*, 13-23.

Gomez, A.K. and Gomez A.A. (1976). *Statistical procedures for agricultural research*. International Rice Research Institute Book, John Willy & Sons.

Husain, K., Dubey S.D., Singh D. and Srivastava R.L. (2017). Effect of nutrient management on yield, economics and nutrient status of soil in maize – linseed cropping system. *J. Pharmacog. Phytochem*., **6(6)**, 327-330.

Kuepper, G.L. and Gegner (2004). *Organic crop production overview*. ATTRA of National Centre for Appropriate Technology.

Kumar, D., Sharma S.K., Kumar B., Kumar S., Kashyap S. and Kumar R. (2022). Potential of Vermiwash Prepared from Different Combinations of Organic Wastes to improve the Growth, Yield and Quality of Organic Black Gram. *Legume Res.-An Int. J*., 1-7. DOI: 10.18805/LR-4957.

Morris, D. (2005). Flax-A health and nutrition Primer. Flax Council of Canada. Available at http://www.flaxcouncil.ca/english/index.phpp=primer&mp=n utrition.

Oilseed Productivity Enhancement through Identified Agro-Technologies in Eastern Region. ICAR-ATARI, Kolkata 2016-17.

Radwanski, S.A. and Wickens G.E. (1981). Vegetative fallows and potential value of the neem tree in the tropics. *Economic Botany*, **35**, 398-414.

Stockdale, C.R., Cohen D.C. and Doyle P.T. (2001). Nutritive characteristics of irrigated perennial pastures in northern Victoria and the selection of nutrients by grazing dairy cows. *Aust. J. Exp. Agricult*., **41(5)**, 601-609.

Samadhiya, H., Dandotiya P., Chaturvedi J. and Agrawal O.P. (2013). Effect of vermivash on the growth and development of leaves and stem of tomato plants. *Int. J. Curr. Res*., **5(10)**, 3020-3023.

Singh, S., Ankit, Manuja S., Rameshwar and Upadhyay R.G. (2023). Agro-techniques for organic linseed production. *International Conferences Natural farming for revitalizing environment and resilient agriculture*.

Tadesse, T., Parven A., Singh H. and Weyessa B. (2010). Estimates of variability and heritability in linseed germplasm. *Int. J. Sust. Crop Prod*., **5(3)**, 8-16.

Trivedi, R. and Bhatt S.A. (2006). Phosphate activity in semiarid soil of pathan. *Asian J. Microbiol., Biotechnol. Environ. Sci*., **8**, 303-305.

Zambare, V.P., Padul M.V., Yadav A.A. and Shete T.B. (2008). Vermiwash: Biochemical and Microbiological Approach as Eco-friendly soil Conditioner. *ARPN J. Agricult. Biolog. Sci*.