Original Research Article

Impact of crop configuration and slag based liquid fertilizers on growth and yieldof oilseed *Brassica*

ABSTRACT

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A field experiments was conducted at the Norman E. Borlaug Crop Research Centre of G.B. Pant University of Agriculture and Technology, Pantnagar, District Udham Singh Nagar, Uttarakhand, which is located at the foothills of Himalayasto study the effect ofcrop configuration and slag based liquid fertilizers on growth and yield of oilseed *Brassica.* The experiment was laid out in split plot design with three replications. The experiment was consisting of one main factor i.e. crop configuration and a sub factor i.e. different types of slag based liquid fertilizers. Main plotconsists of P_1- *Brassica juncea* in 22.5cm apart rows with alternate row extraction 30 DAS, P_2- *Brassica juncea* in 22.5cm apart rows with 50:50 alternate row extraction 20 DAS and 40 DAS, P_3- *Brassica napus* and *Brassica rugosa* in 22.5cm apart rows extracting *Brassica rugosa* 30 DAS, P_4- - *Brassica napus* and *Brassica rugosa* in 22.5cm apart rows extracting *Brassica rugosa* 50:50, 20 and 40 DAS. Sub plot consist of L_1 (liquid fertilizer 1), L_2 (liquid fertilizer 2), L_3 (liquid fertilizer 3), C (Control). Crop configuration and slag based liquid fertilizers significantly influenced growth and yield parameters. Plant height, dry matter production, leaf area index (LAI), no. of siliquae per plant and seed yield were significantly higher in plant configuration involving *Brassica napus* and *Brassica rugosa* in 22.5cm apart rows extracting *Brassica rugosa* 30 DAS and liquid fertilizer 3 in compare to others. Optimal crop configuration like P_3 with tailored fertilizer, L_3 improved the growth and yield of *Brassica* species in compare to others.

Keywords: [Brassica, crop configuration, slag-based fertilizers}

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1. INTRODUCTION

Edible oils from plants are vital for human nutrition and are key components in many industrial product stands out as one of the top global producers of oilseeds, which are crucial to its economy. Among these, rapeseed-mustard is especially important, ranking just behind groundnut and soybean as a primary edible oilseed crop. Despite being the fourth-largest producer of vegetable oil globally, following China, Brazil, and the United States, India still a substantial amount of oilseeds to meet domestic demand.

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Rapeseed-mustard, part of the Brassicaceae family, is a crucial source of edible oils in India. Rankin globally in both area and production, India follows the European Union, Canada, and China in cultivating this crop. Rapeseed-mustard thrives as a winter crop in cooler temperatures with adequate soil moisture during growth and dry conditions for harvest**(Chauhan *et al*., 2011).**

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Plant density significantly impacts seed yield and other important agronomic traits. In oilseed rape, row spacing and plant density vary worldwide, depending on the environment, production system, and cultivar.Various nutrients and micronutrients are essential for the growth of oilseed crops, particularly those in the Brassicaceae family, agriculture has relied heavily on fertilizers, boosting grain yields worldwide over the past six decades. However, pr use of chemical fertilizers has also resulted in declining crop yields and soil fertility in intensive farming syste chemical composition of the elements like CaO, SiO_2, and MgO in steel slag is similar to the raw inorganic fertilizer

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material, making it a viable option for soil enhancement and fertilizer manufacturing**.** Slag-based fertilizers, including slag silicate, lime, phosphate, and special iron matter fertilizers have shown promising results in enhancing crop productivity, **(White et al.,2017).** Using renewable sources and inputs is a key concept in sustainable agriculture, aiming for maximum crop productivity with minimal environmental impact. Therefore, achieving higher yields with reduced environmental risks necessitates new cultivation techniques that incorporate organic and liquid fertilizers.

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2. MATERIAL AND METHODS

A field experiments was conducted at the Norman E. Borlaug Crop Research Centre of G.B. Pant University of Agriculture and Technology, Pantnagar, District Udham Singh Nagar, Uttarakhand, which is located at the foothills of Himalayas during *Rabi* season of 2022-23 and 2023-24.The experiment was laid out in split plot design with three replications. The experiment was consisting of one main factor i.e. crop configuration and sub factor i.e. different types of slag based liquid fertilizers. A total 16 treatments formed with combinations of fourMain plot i.e. P_1- *Brassica juncea* in 22.5cm apart rows with alternate row extraction 30 DAS, P_2- *Brassica juncea* in 22.5cm apart rows with 50:50 alternate row extraction 20 DAS and 40 DAS, P_3- *Brassica napus* and *Brassica rugosa* in 22.5cm apart rows extracting *Brassica rugosa* 30 DAS, P_4- *Brassica napus* and *Brassica rugosa* in 22.5cm apart rows extracting *Brassica rugosa* 50:50, 20 and 40 DAS and four Sub plot consist of L_1 (liquid fertilizer 1), L_2 (liquid fertilizer 2), L_3 (liquid fertilizer 3), C (Control).

The crop was provided with initial spacing of 22.5cm, with the alternate rows were removed as per the treatments with final spacing becoming 45cm with 6.3 m × 5 m = 31.5 m^2plot size.(Write the method, which is used for analysing the data). Slag based fertilizers were prepared with industrial slag along with organic and inorganic substances. They were applied at the time of sowing as soil drenching while in control plot, only water was applied.

3. RESULTS AND DISCUSSION

3.1 Growth parameters

At harvest, P_3 (*B. napus;* with *B. rugosa* row extraction 30 DAS) shown maximum plant height during both the year being statistically at par with P_4 (*B. napus;* with *B. rugosa* 50:50 row extraction 20 and 40 DAS)while it was significantly higher over that of two configurations involving *B. juncea*. P_1 (*B. juncea*;alternaterow extraction 30 DAS) was significantly higher over P_2(*B. juncea*; 50:50 alternate row extraction 20 and 40 DAS) in terms of height during both the year. Among the slag based liquid fertilizers, L_3 (Liquid fertilizer 3) shown maximum plant height during both the year being significantly superior over that of other liquid fertilizers. Among the other two liquid fertilizers, L_2 (Liquid fertilizer 2) also significantly superior over L_1 (Liquid fertilizer 1) and C (Control) while L_1 (Liquid fertilizer 1) and C (Control) were statistically at par during both the years.This shift indicates that while *B. juncea*configurations are beneficial in the early stages, *B. napus* configurations support better final growth, possibly due to differences in growth dynamics and nutrient requirements between species. Similar observations were made by **Thomas *et al.* (2022),** who noted species-specific growth responses in *Brassica* under different agronomic practices.

At harvest, P_3 (*B. napus;* with *B. rugosa* row extraction 30 DAS) exhibited the maximum dry matter accumulation, significantly higher than P_4 and configurations involving *B. juncea* (P_1 and P_2). Among the fertilizers, L_3 maintained the highest accumulation, significantly superior to others. The control group consistently showed the lowest dry matter accumulation across all stages and years.These findings indicate that specific crop configurations and the application of balanced slag-based liquid fertilizers, particularly L_3, significantly enhance dry matter accumulation in *Brassica* species. This aligns with previous research emphasizing the importance of optimized nutrient management and crop configuration in improving *Brassica* growth and productivity**.**Similar trends were observed by **Kumar *et al.* (2024),** who noted the positive effects of strategic nutrient management on dry matter accumulation in *Brassica* species**.**The same trend was observed in LAI at 90DAS for both the years.

The interaction between crop configuration and slag based liquid fertilizers was not found significant.

3.2 Yield parameters

The P_3 configuration (*B. napus* with *B. rugosa* row extraction at 30 DAS) consistently resulted in the highest number of siliquae per plant and more numbers of seeds per siliqua. across both years. Among the fertilizers, L_3 (Liquid fertilizer 3) had the highest number of siliquaeand more numbers of seeds per siliquae, highlighting the effectiveness of slag-based fertilizers in promoting reproductive growth. Studies have shown that liquid fertilizers can significantly improve the reproductive traits of crops **(El Boukhari *et al*., 2020).**

P_3 (*B. napus;* with *B. rugosa* row extraction 30 DAS) produced the maximum seedyield being significantly superior over to that of other crop configurations during both the years. P_4 (*B. napus;* with *B. rugosa* 50:50 row extraction 20 and

40 DAS) also produced significantly higher seed yield over that of the two configurations involving *B. juncea*. The higher seedyield in these treatments are the result of a greater number of siliquae per plantand more numbers of seeds per siliqua. The increase in seed yield is largely a function of improvement in the yield attributes. P_1 (*B. juncea*;alternaterow extraction 30 DAS) also remains significantly superior over P_2 *(B. juncea*; 50:50 alternate row extraction 20 and 40 DAS) in terms of seed yield yieldduring both years.The higher productivity of P_3 and P_4 configurations can be attributed to the complementary growth patterns and nutrient utilization between *B. napus* and *B. rugosa*, enhancing overall productivity and resource use efficiency. These findings align with those of **Singh *et al*. (2019).** Among the slag based liquid fertilizers, L_3 (Liquid fertilizer 3) produced significantly superior seed yield over that of L_1 and L_2. Though L_1 produced higher seed yield over control but it did not differ statistically.In present study, significantly more grain yield was observed in L_3 (Liquid fertilizer 3)might be due to improved nutrient content in slag-based fertilizers including FeO, MnO, and P_2O_5, which helped in production of more dry matter, number of branches and yield attributes(**Yi *et al.*, 2012, Das *et al.*, 2019)**.Harvest index (HI) was non-significant during both the years.

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The interaction between crop configuration and slag based liquid fertilizers was not found significant**.**

Table 1. Effect of crop configuration and slag based liquid fertilizers on growth parameters of oilseed *Brassica*

Treatments	Plant height (cm)		Drymatter accumulation(g)		LAI	
	2022-23	2023-24	2022-23	2023-24	2022-23	2023-24
Crop configuration (P)						
P_1(*B. juncea*;alternaterow extraction 30 DAS)	181.3	192.5	49.53	50.61	3.19	3.28
P_2(*B. juncea*; 50:50 alternate row extraction 20 and 40 DAS)	172.6	181.2	45.78	46.56	3.03	3.10
P_3(*B. napus;* with *B. rugosa* row extraction 30 DAS)	205.8	216.3	54.12	56.17	4.39	4.39
P_4 (*B. napus;* with *B. rugosa* 50:50 row extraction 20 and 40 DAS)	201.8	210.4	50.28	52.28	4.22	4.21
SEm±	2.4	3.9	0.57	0.85	0.05	0.06
CD (P=0.05)	8.4	11.4	1.99	2.94	0.14	0.17
Slag basedliquid fertilizer (L)						
L_1(Liquid fertilizer 1)	186.8	195.8	49.07	50.18	3.72	3.73
L_2(Liquid fertilizer 2)	193.3	203.1	50.52	52.26	3.75	3.77
L_3(Liquid fertilizer 3)	201.1	211.3	52.78	54.46	3.89	3.92
C (Control)	179.9	190.1	47.21	48.52	3.64	3.61
SEm±	2.4	2.5	0.66	0.82	0.04	0.05
CD (P=0.05)	7.0	7.4	1.93	2.34	0.11	0.13
Interaction (PXL)	NS	NS	NS	NS	NS	NS

Table 2. Effect of crop configuration and slag based liquid fertilizers on yield parameters of oilseed *Brassica*

Treatments	Numberof siliquaeperplant		Seedspersiliquae		Seed yield (kg/ha)		HI	
	2022-23	2023-24	2022-23	2023-24	2022-23	2023-24	2022-23	2023-24
Crop configuration (P)								
P_1(*B. juncea*;alternaterow extraction 30 DAS)	181.3	192.5	15.27	15.29	1719	1820	22.2	22.4
P_2(*B. juncea*; 50:50 alternate row extraction 20 and 40 DAS)	172.6	181.2	14.95	14.98	1552	1651	22.3	22.5
P_3(*B. napus;* with *B. rugosa* row extraction 30 DAS)	205.8	216.3	18.92	20.71	2129	2257	22.9	23.3
P_4 (*B. napus;* with *B. rugosa* 50:50 row extraction 20 and 40 DAS)	201.8	210.4	18.56	19.46	1981	2108	22.7	22.9

SEm±	2.4	3.9	0.27	0.32	40	37	0.5	0.2
CD (P=0.05)	8.4	11.4	0.95	0.96	137	126	NS	NS
Slag basedliquid fertilizer (L)								
L_1(Liquid fertilizer 1)	186.8	195.8	16.61	17.25	1764	1871	22.4	22.6
L_2(Liquid fertilizer 2)	193.3	203.1	17.17	17.83	1891	2008	22.7	22.8
L_3(Liquid fertilizer 3)	201.1	211.3	17.82	18.42	2048	2180	22.8	23.1
C (Control)	179.9	190.1	16.12	16.71	1678	1778	22.0	22.2
SEm±	2.4	2.5	0.29	0.27	36	35	0.3	0.4
CD (P=0.05)	7.0	7.4	0.86	0.81	104	104	NS	NS
Interaction (PXL)	NS	NS	NS	NS	NS	NS	NS	NS

4. CONCLUSION

With altered plant configuration,*B. napus;* with *B. rugosa* row extraction 30 DASalong with tailored source of nutrients i.e. liquid fertilizer 3 made of using non-conventional materials can improve the growth and yield of *Brassica* species which can pave the way for sustainable agriculture with improved fertilization and even can be acted as a new source of fertilizer.

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ABBREVIATIONS

LAI- LEAF AREA INDEX
HI – HARVEST INDEX