Original Research Article

Potential of Foliar Applied Nano Fertilizer in Improving the Growth, Yield and Quality of Gobhi Sarson (*Brassica napus*)

ABSTRACT

A field experiment was conducted in the Research farm of the School of Agriculture, Lovely Professional University, Punjab to find out the potential of foliar-applied nano fertilizer in improving the growth, yield and quality of Gobhi sarson (*Brassica napus*). The experiment was laid out in Randomized Block Design (RBD) with four replications. The experiment consisted of five treatments *viz*. T1: Control, T2: 50% RDF + Nano NPK (19:19:19) @ 0.2% as foliar spray at 30 DAS, T3: 75% RDF + Nano NPK (19:19:19) @ 0.2% as foliar spray at 30 DAS, T4: 100% RDF + Nano NPK (19:19:19) @ 0.2% as foliar spray at 30 DAS and T5: 125% RDF + Nano NPK (19:19:19) @ 0.2% as foliar spray at 30 DAS. The application of 100% RDF + Nano NPK (19:19:19) @ 0.2% as a foliar spray at 30 DAS (T4) recorded the highest plant height (184.75 cm), seed yield (22.80 q ha^{-1}) and stover yield (49 q ha^{-1}). More oil (43.32%) and protein (31.73%) content were also recorded in T4 as compared to other treatments. The overall results showed that foliar application of nano fertilizer in combination with conventional fertilizer significantly improved the growth, yield and quality of Gobhi sarson (*Brassica napus*).

Keywords: Nano fertilizers, Nano NPK fertilizers, NPK (19:19:19) and Gobhi Carson.

1. INTRODUCTION

Throughout the beginning of time, India's agricultural economy has been based primarily on oil-seed crops. About 10% of all oilseeds and 14% of all vegetable oil production come from *Brassica spp*. [1]. With a 26.0% share of India's total oilseed production, rapeseed and mustard are the country's principal Rabi oilseed crops. They rank second in the oilseed economy to groundnut [2]. Rapeseed-mustard was the second-most significant edible oilseed crop grown in India in 2019-20, behind soybean, in terms of area, production, and productivity (6.86 million ha, 9.12 million tonnes, and 1331 kg/ha, respectively) [3].

Gobhi sarson (*Brassica napusL*.), commonly known as Canola or Canadian oil crop, has become more important because of its photosensitivity and thermosensitivity and is displacing Indian mustard in the country's cooler regions like Punjab and Himachal Pradesh. A high-yielding, high-oil (41-45%) cultivar with a notable oleic, linoleic, and linolenic acid content is an amphiploid cross between *Brassica campestris* and *Brassica oleracea*. Currently, the cooler portions of Himachal Pradesh have marginal production (12-14 q ha^{-1}) compared to Punjab (16-18 q ha^{-1}) [4]. The 155-day Gobhi sarson crop is unique to Punjab, Himachal Pradesh, and Haryana. With 2.50 million hectares and 4.08 million tonnes of production in 2017 alone, Rajasthan has the highest amounts of rapeseed and mustard. Rapeseed and mustard make up 28.6% of all oilseeds produced, and they are India's most significant rabi oilseed crop, contributing 27.8% to the nation's oilseed economy [5].

Poor marginal land, sparse fertilizer application, and a lack of irrigation facilities are the main causes of India's lower rapeseed and mustard yields. Excessive fertilizer and pesticide use have altered soil fertility and integrity, negatively affecting the environment and ecology. Nanotechnology presents a promising answer to all these problems that can help ensure long-term soil health and agricultural output [6]. The use of nano fertilizers holds great potential for maintaining agricultural productivity and soil health. Nanoparticles are extremely small, with at least one dimension being less than 100 nm (on the order of magnitude 10^{-9}). It should be done so that they have all the required qualities, including increased targeted activity with lower ecotoxicity, stability, effectiveness, and higher surface area [7].

To minimize nutrient loss and yield gaps and still achieve sufficient production at a consistent rate, it is now required to switch from conventional farming to modern agricultural practices. In this case, nanotechnology may be crucial in resolving these issues through the balanced application of nutrients as nano-fertilizers and presents numerous prospects for offering a workable substitute for agriculture and food processing [8,23,24]. While foliar spray can successfully cover crop nutrient needs, nanoscale materials can increase the efficacy of fertilizer use. Due to their special characteristics, nano fertilizers enhance plant performance in terms of extremely high absorption, enhanced production, higher photosynthesis, and a notable rise in the leaf surface area. The use of nano fertilizers in place of conventional fertilizers prevents water contamination by releasing nutrients into the soil continuously and under controlled conditions [9]. The intervention of nanotechnology and organic farming practices can help minimize the mass volume requirement of conventional chemical fertilizer while improving crop production [10]. Thus, the present study aims to explore the potential of foliar-applied nano fertilizers in combination with conventional fertilizers in improving the growth and yield of Gobhi sarson (*Brassica napus*).

2. MATERIALS AND METHODS

During the Rabi season of 2022-2023, the field experiment was conducted at Research Farm, School of Agriculture, Lovely Professional University, Punjab. The objective of the present field experiment was to see the response of Gobhi sarson (*Brassica napus*) to foliar application of Nano NPK in combination with conventional fertilizers on growth and yield. The experiment was laid out in a Randomized Block Design with four replications having a plot size of 20 m^2 (5 x 4 m). The experiment consists of five treatments *viz.*T1: Control, T2: 50% RDF + Nano NPK (19:19:19) @ 0.2% as foliar spray at 30 DAS, T3: 75% RDF + Nano NPK (19:19:19) @ 0.2% as foliar spray at 30 DAS, T4: 100% RDF + Nano NPK (19:19:19) @ 0.2% as foliar spray at 30 DAS and T5: 125% RDF + Nano NPK (19:19:19) @ 0.2% as foliar spray at 30 DAS.

A composite soil sample was taken from the experimental site from a depth of 15 cm before the experiment was initiated in the field for various soil analysis. The soil of the experimental field was sandy loam with alkaline pH (8.10) with electrical conductivity of 0.15 dSm^{-1}, low organic carbon (0.31%), low available Nitrogen (294.78 $kgha^{-1}$), whereas high available Phosphorus (82.20 $kgha^{-1}$) and medium available Potassium (113.12 $kgha^{-1}$). The variety under study was GSC-7 (canola quality variety) which is a medium-tall variety free from white rust and tolerant to Alternaria blight. Its average yield is 8.9 q/acre with 40.5% oil content and it matures in 154 days. The variety was planted with a spacing of 45 x 15 cm and the recommended dose of nutrient (40:12:00 NPK kg/acre) was applied as per the treatment designation. Foliar application of Nano-NPK (19:19:19) fertilizer was done @ 0.2% concentration before flowering at 30 DAS with the help of a knapsack sprayer and several other agronomic practices were also done uniformly in all the treatments. The observations were recorded per the random 5 plants selected within each net plot. Parameters for growth include plant height, plant population, number of primary and secondary branches and the yield parameters include number of siliquae per plant, length of siliquae, number of seeds per siliquae, test weight and seed yield.

2.1 Oil content

The Soxhlet method given by Sankaran (1966) estimated oil content in seed. Seed samples of five grams each from all the plots were taken to extract the oil. The crushed seed samples were placed in a thimble and oil was extracted with light petroleum ether for six hours in a Soxhlet extraction unit. The formula used for the calculation of percent oil content in seeds is shown below:

Oil content (%) = ———————————— x 100

2.2 Protein content

The protein content of the seeds was estimated by first estimating the percent of nitrogen content in the seeds by the Kjeldhal method (1956) and the percent of protein content in the seeds was calculated by multiplying with a factor (6.25). The formula used for the calculation of protein content in seeds is given below:

Protein content (%) = % Nitrogen x 6.25

2.3 Statistical Analysis

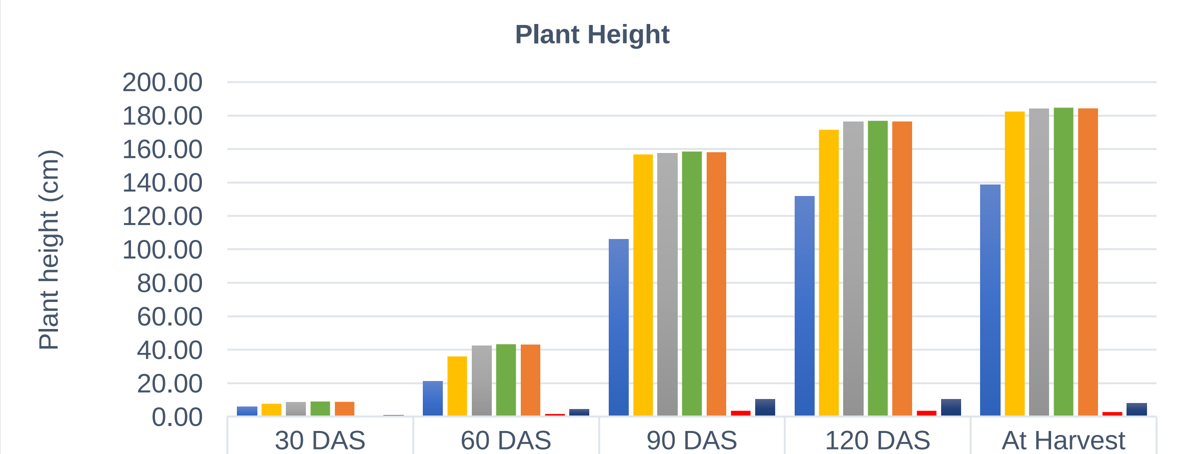
All the data about the present study were statistically analyzed for randomized block design adopting the procedure of 'analysis of variance' (ANOVA) given by Panse and Sukhatme (1985). The significance of the variance due to the treatment effect was determined by calculating the respective 'F' values. The difference in treatment mean was tested by using Critical difference (CD) at 5% levels of significance.

3. RESULTS AND DISCUSSION

3.1 Growthattributes

The data on growth attributes of Gobhi sarson *viz.* plant height (Fig. 1) and the number of branches plant^{-1} and plant population at harvest, as influenced by foliar application Nano NPK in combination with conventional fertilizer, are shown in Table 1.

The results showed that the application of 100% RDF + Nano NPK (19:19:19) @ 0.2% as a foliar spray at 30 DAS (T4) recorded the highest plant height at 30, 60, 90, 120 DAS and at harvest, which was statistically at par with T3 and T5 while the lowest plant height was recorded in control (138.70 cm at harvest). The increase in plant height may be because foliar application of nano NPK fertilizers increased the nutrient uptake efficiency by facilitating better intake to plant leaves and enhanced plant growth. The results agreed with the findings of Drostkar*et al*. [11], Alzreejawi*et al*. [12]and WA Al-Juthery*et al*. [13]. Alhasan[14] also reported a significant increase in plant height by applying different rates of NPK nano fertilizer.



	30 DAS	60 DAS	90 DAS	120 DAS	At Harvest
T1	5.88	21.25	106.15	131.75	138.7
T2	7.75	36	156.75	171.5	182.45
T3	8.83	42.5	157.45	176.25	184.1
T4	8.90	43.25	158.4	176.75	184.75
T5	8.88	43	158.05	176.5	184.35
SEm±	0.3	1.5	3.4	3.4	2.6
CD (P≤0.05)	1	4.6	10.5	10.4	8.1

Fig. 1. Effect of Nano NPK in combination with Conventional fertilizers on plant heightof Gobhi sarson.

The maximum plant population at harvest (29.5 m^{-2}) was recorded with the application of 100% RDF + Nano NPK (19:19:19) @ 0.2% as a foliar spray at 30 DAS (T4) while the least plant population was recorded in T1 (control). The results presented in Table 1 have indicated that number of branches (both primary and secondary branches $plant^{-1}$) at harvest was significantly influenced by the application of 125% RDF + Nano NPK (19:19:19) @ 0.2% as a foliar spray at 30 DAS (T5) which was statistically at par with T2. These results correspond with the findings of Aziz *et al*. [15]. Drostkar*et al*., (2016) have also demonstrated that the foliar application of nano fertilizers significantly influenced the number of primary and secondary branches per plant. Al-Juthery*et al*. [16] reported that NPK is essential to crop development and is crucial to the country's food security. The role that these NPK fertilizers play in providing the essential nutrients for plant growth explains their significance. Applying a nano-chelated fertilizer compound including micronutrients N, P and K to grain crops seemed to improve nutrient uptake and utilization. Since nano fertilizers are more effective than mineral fertilizers, foliar spraying with NPK nano fertilizer significantly contributed to the increase in most growth indices (Shareef *et al*. [17].

Table 1.Effect of Nano NPK in combination with Conventional fertilizers on Growthattributes of Gobhi sarson.

TREATMENT	No. of branches $plant^{-1}$ (at harvest)		Plant population m^{-2} (at harvest)
	Primary branches	Secondary branches	
T1	3.0	4.5	24.3
T2	4.8	6.8	25.8
T3	4.3	6.3	27.0
T4	4.0	6.3	29.5
T5	4.8	6.8	28.0
SEm±	0.3	0.4	1.1
CD (*P*= .05)	1.1	1.1	3.4

3.2 Yield Attributesand Yield

The results in Table 2 indicated that the application of Nano NPK in combination with conventional fertilizers has significantly influenced the yield and yield attributing characters of Gobhi sarson.

Table 2. Effect of foliar application of Nano NPK in combination with Conventionalfertilizers on Yield and Yield parameters of Gobhi sarson.

Treatment	Length of Siliqua/plant (cm)	No. of Siliquae/ plant	No. of Seeds/ Siliqua	Test weight (g)	Seed Yield (q/ha)	Stover Yield (q/ha)	Biological Yield (q/ha)	Harvest Index (%)
T1	4.63	179.25	10.7	3.84	5.98	15	20.98	28.11
T2	5.10	335	12.7	4.28	16.65	41.50	58.15	28.18
T3	5.48	466.75	14.4	4.54	22.18	48.75	79.93	32
T4	5.65	469.25	14.6	4.77	22.80	49	71.80	32.25
T5	5.63	468.50	14.4	4.66	22.38	48.68	71.05	31.37
SEm±	0.2	37.3	0.7	0.2	1.7	4.9	5.7	2.4

CD(*P* = .05)	0.7	115	2.1	NS	5.2	15	17.5	NS

3.2.1 Yield attributes

The length of siliqua plant^{-1} (5.65 cm), no. of siliquae plant^{-1} (469.25) and the no. of seeds siliqua^{-1} (14.6) were recorded to be the highest in T4 (100% RDF + Nano NPK (19:19:19) @ 0.2% as a foliar spray at 30 DAS)which was found to be significantly at par with T3 and T5. At the same time, the lowest length of siliqua plant^{-1} (4.63 cm), no. of siliquae plant^{-1} (179.25) and the no. of seeds siliqua^{-1} (10.7) were recorded in the control treatment (T1). In comparison, the test weights were found to be non-significant in all the respective treatments. The results agreed with the findings of Aziz *et al*., (2021). Upadhyay *et al*. [18] have also unveiled that the combined effect of nano fertilizers and conventional fertilizers has immense scope to improve crop yield.

3.2.2 Yield

The maximum seed yield (22.80 q ha^{-1}), stover yield (49 q ha^{-1}), biological yield (71.80 q ha^{-1}) and harvest index (32.25 %) were recorded by the foliar application of 100% RDF + Nano NPK (19:19:19) @ 0.2% as a foliar spray at 30 DAS (T4) in which was found to be significantly at par with T3 and T5. Meanwhile, the lowest seed yield (5.98 q ha^{-1}), stover yield (15 q ha^{-1}), biological yield (20.98 q ha^{-1}) and harvest index (28.11%) were recorded in T1 (control treatment). However, the harvest index was found to be non-significant in the treatments. The findings of Alzreejawi*et al*., (2020) have also shown the significant superiority of nano NPK spray in achieving the highest means for grain yield and harvest index. Increased in yield and yield attributes by the foliar application of Nano NPK fertilizers in combination with conventional fertilizers has been reported by Vadlamudi *et al.*[19].Drostkar*et al.,* (2016) have also revealed that the foliar application of nano fertilizer significantly affected the seed yield and plant biomass, consequently increasing the harvest index. Al-Uthery*et al*. [20] concluded that the adoption of fertigation in conjunction with nano N, P, and K fertilizers, as well as good irrigation management with drip irrigation, high WUE, AE, and EUE and a uniform distribution of nutrients in the soil can result in good potato productivity. WA Al-Juthery et al., (2019) also agreed with these findings.

3.3 Quality Attributes

The data regarding protein content and oil content as influenced by the application of Nano NPK in combination with conventional fertilizers in the quality of Gobhi sarson presented in Fig 2. has shown that the maximum protein content (%) and oil content (%) was obtained from T4 (100% RDF + Nano NPK (19:19:19) @ 0.2% as a foliar spray at 30 DAS). Statistically, T4 has the maximum protein content (31.73 %) and oil content (43.32%) which was also at par with the results obtained from T3 and T5. While the least oil and protein content was obtained in T1 (Control). The results are in agreement with those of M.M. Abd El-Azeim*et al*. [21] who reported that nano fertilizers play a significant role in sustaining the productivity and quality of potatoes and can be completely in lower rates substitute chemical fertilizers. The application of nano-fertilizers led to higher crop quality than the use of traditional fertilizers (El-Saadony*et al*. [22].

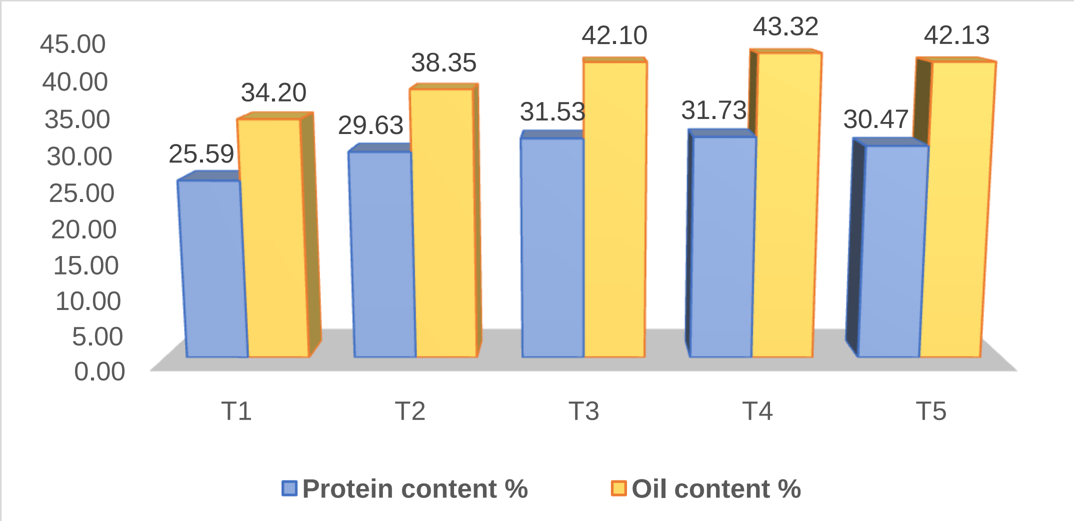


Fig. 2. Effect of Nano NPK in combination with Conventional fertilizers on protein contentandoil content of Gobhi sarson.

4. CONCLUSION

The findings of the present study revealed that theapplication of 100% RDF + Nano NPK (19:19:19) @ 0.2% as a foliar spray at 30 DAS(T4) significantly produced higher plant height, number of branches, number of siliquae and seed yield as compared to the control treatment, which remained at par with 75% RDF + Nano NPK (19:19:19) @ 0.2% as a foliar spray at 30 DAS (T3). Quality attributes such as the oil and protein content in Gobhi sarson were recorded to be higher in T4, which remained at par with T3 and T5. Therefore, it can be concluded that foliar application or spraying of nano NPK fertilizers in combination with conventional fertilizers can be suggested as it can improve or promote the overall growth, yield and quality of Gobhi sarson.

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