

Original Research Article

Effect of Irrigation frequencies and Foliar application of Zinc and Boron on Growth and Yield of Yellow Sarson (*Brassica rapa*)

ABSTRACT

A field experiment was carried out during winter (*Rabi*) season of 2021-22 on sandy loam soil at C.S. Azad University of Agriculture & Technology, Kanpur (U.P.) to study the Growth, yield of Yellow Sarson (*Brassica rapa*) influenced by different irrigation frequencies and foliar application of micro nutrients (Zinc and Boron). Three irrigation (main plot) and four micro nutrients level (sub plot) treatments were tested with "Split Plot Design" to know the influence of irrigation frequencies and micronutrients level on Yellow Sarson. To assess the effect of irrigation frequencies on yellow sarson, the treatment included IR₁(one irrigation at 30 DAS), IR₂(two irrigations at 30 and 55 DAS) and IR₃(three irrigations at 30 DAS, 55 DAS and 90 DAS) and to assess the effect of micronutrients level, the treatments were F₀(control), F₁(0.5% zinc at 30-35 and 40-45 DAS) and F₂(0.2% boron at 30-35 and 40-45 DAS) and F₃(0.5% zinc+0.2% boron at 30-35 and 40-45 DAS). Treatment IR₃ found to be significantly superior over IR₂ and IR₁ treatments. The maximum seed yield was with the three irrigation frequencies IR₃ (30+55+90 DAS) which were higher by 10.56 and 37.23 per cent than IR₂ and IR₁ treatments respectively. Regarding to micronutrients the maximum seed yield was obtained in F₃ treatment which was higher by 8.21, 14.42 and 21.78 percent than F₂, F₁ and F₀ treatment in relative manner. The maximum seed yield was obtained with IR₃ X F₃ interaction which was higher by 21.70, 13.20 and 7.92 per cent then IR₃F₀, IR₃F₁, and IR₃F₂ treatment combination.

Keywords: *foliar, micronutrients and irrigation frequencies*

Introduction

Rapeseeds and Mustard are an important *rabi* season oilseed crop in India which belongs to the family Cruciferae. Rapeseed and Mustard is a prominent Oil seed crop being next to Soyabean. India is one of the top countries in the world for producing oilseeds, accounting for 10% of global production and 16.2% of the world's total area. Within the category of field crops, oilseed is India's second-largest agricultural product after cereals. It significantly

affects the value of all agricultural commodities in India. In addition to being a fundamental component of the human diet, oils and fats are important raw materials used to make a variety of products, including soap, paint, hair oils, lubricants, varnishes, pharmaceuticals, auxiliaries, textiles, etc. It contributes significantly to the Indian economy, making up 12 percent of the value of all agricultural commodities, around 3.0 percent of the gross national production, and 27 percent of the gross cultivated area (rapeseed and mustard). Only seven of these oilseed crops groundnut, rapeseed, and mustard; soybean, sesame, sunflower, safflower, and Niger are suitable for human consumption. Linseed and castor are not suitable for human consumption. (DAC&FW, Annual Report 2020-21).

Comment [U1]:

Mustard contains 37-49% oil, 25-32% protein, 7% ash, 0.6% calcium, 1.45% phosphorus, 0.6% magnesium, 0.05% manganese and good source of vitamins, thiamine 5.2 (mg g⁻¹), niacin 160 (mg g⁻¹), riboflavin 3.7 (mg g⁻¹), pantothenic acid 9.5 (mg g⁻¹), folic acid 2.3 (mg g⁻¹), chlorine 6.7 (mg g⁻¹), and tocopherols 1.5 (mg g⁻¹). The cake contains 42% crude proteins and 7% ash (Directorate of Economics and Statistics, 2010).

Zinc is an important constituent of several enzymes which regulates various metabolic processes in the plants and also influences the formation of several growth hormones like IAA in plants. Zinc stimulates the pod setting, seed formation and oil synthesis in the seeds of mustard and it increases the biological seed and stover yield of mustard (Meena *et al.*, 2016). Mustard is quite responsive to micronutrients zinc (Zn) and boron (B), which plays important role in growth and development of this crop. Availability of boron to plant is affected by variety of soil factor including soil pH, texture, moisture, temperature, oxide content, carbonate content, organic matter content and clay mineralogy (Goldberg *et al.*, 2000). Its deficiency has been realized as the second most important micronutrient constraint in crops after that of zinc on global scale (Ahmed *et al.*, 2012). Boron also helps in flowers and pollen grain formation. Boron application produced the best quality of seeds in respect of protein content of mustard. Boron deficiency in mustard may cause sterility i.e., less pods and less seeds pod⁻¹, attributing low seed yield (Islam and Anwar 1994).

Materials and Methods

Experimental Site

The experiment was conducted at SIF, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur. The City Kanpur Nagar is situated in the alluvial tract of

Gangetic plains in Central part of Uttar Pradesh between 25°56' to 28°58' North latitude and 79°31' to 80° East longitudes and at an elevation of 125.9 meter from sea level. It is situated in the alluvial belt of Gangetic plain of central U.P. India.

Edaphic Condition

The soil of the experimental field was sandy loam in texture and slightly alkaline in pH (7.3). Organic carbon in the soil was 0.4% which was estimated by rapid titration method given by **Walkley and Black, 1934**. The available Nitrogen in soil was 217.0 kg ha⁻¹, which was estimated by the Alkaline permanganate method given by **Subbiah and Asija, 1956**. The available Phosphorus was 17.0 kg ha⁻¹ estimated by Olsen's method given by **Jackson, 1967**. The available K was 145.0kg ha⁻¹ which was estimated by the Flame photometer method given by **Jackson, 1967**.

Experimental Details:

The experiment was laid out in split-plot design with three replications. The main plot treatment consisted of three levels of irrigation viz. IR₁ (one irrigation at 30 DAS), IR₂ (two irrigations at 30 DAS and 55 DAS), IR₃ (three irrigations at 30 DAS, 55 DAS and 90 DAS), whereas four levels of (micronutrients Zinc & Boron) i.e., F₀ (control), F₁ (0.5% Zinc), F₂ (0.2% Boron) and F₃ (0.5% zinc + 0.2% boron) were applied to sub-plots. So, the total number of treatment combinations were twelve. The treatments were replicated thrice to avoid any effect of heterogeneity. The treatments within main plots and sub-plots were allocated randomly in each replication as per the standard procedure. The treatment details with symbolic representation are given in Table 1.

Table 1: Treatment combinations

| Symbol | Treatments |
|--------------------------------|--|
| IR ₁ F ₀ | One irrigation (30DAS) + control |
| IR ₁ F ₁ | One irrigation (30DAS) + Zn @ 0.5% at 30-35 DAS and 40-45 DAS |
| IR ₁ F ₂ | One irrigation (30DAS) + B @ 0.2% at 30-35 DAS and 40-45 DAS |
| IR ₁ F ₃ | One irrigation (30DAS) + Zn @ 0.5% and B @ 0.2% at 30-35 DAS and 40-45 DAS |
| IR ₂ F ₀ | Two irrigations (30DAS+55DAS) + Control |

| | |
|--------------------------------|--|
| IR ₂ F ₁ | Two irrigations (30DAS+55DAS) + Zn @ 0.5% at 30-35 DAS and 40-45 DAS |
| IR ₂ F ₂ | Two irrigations (30DAS+55DAS) + B@ 0.2% at 30-35 DAS and 40-45 DAS |
| IR ₂ F ₃ | Two irrigations (30DAS+55DAS) + Zn @ 0.5% and B @ 0.2% at 30-35 DAS and 40-45 DAS |
| IR ₃ F ₀ | Three irrigations (30DAS+55DAS+90DAS) + Control |
| IR ₃ F ₁ | Three irrigations (30DAS+55DAS+90DAS) + Zn @ 0.5% at 30-35 DAS and 40-45 DAS |
| IF ₃ F ₂ | Three irrigations (30DAS+55DAS+90DAS) + B @ 0.2% at 30-35 DAS and 40-45 DAS |
| IR ₃ F ₃ | Three irrigations (30DAS+55DAS+90DAS) + Zn @ 0.5% and B@ 0.2% at 30-35 DAS and 40-45 DAS |

Land preparation:

Land preparation was started after harvesting of *kharif* crop, pre-sowing irrigation was given to the field for proper germination of seed. One ploughing was done by disc plough followed by two cross ploughing by tractor drawn cultivator and each ploughing followed by planking so that the soil was done properly so as make the soil firm, friable and level to ensure proper germination of seed.

Nutrient application:

The fertilizers were applied at the rate of 120kg N, 60kg P₂ O₅, and 60kg K₂O ha⁻¹. Full amount of phosphorus and potash and 75% nitrogen was applied as basal at the time of sowing in the form of Urea, DAP and MOP while the remaining amount of nitrogen was applied after first irrigation as top dressing. For the requirement of Zn at the rate of 0.5% was applied as spray as per treatment from Zinc sulphate. And for the requirement of Boron as the rate of 0.2% was applied as spray as per treatment from Borax.

Sowing

After the final field preparation, the seed of **Pitambari** Yellow sarson were sown at the rate of 5 kg ha⁻¹ at a row distance 45 cm. The variety is an early maturing variety. It takes 110-

115 days to mature in Rabi season. It is suitable for growing in whole Uttar Pradesh. The height of plant is 135-145 cm. The potential yield of this variety is 22.38 q ha⁻¹.

Results and Discussion

Effect of irrigation frequencies and micronutrients spray on Growth characters of Mustard

An explicit effect of irrigation frequencies was observed on growth attributing characters of rapeseed plant viz., plant height, primary and secondary branches plant⁻¹ of crop during the experimentation. Application of three irrigations at 30 DAS, 55 DAS and 90 DAS (IR₃) significantly enhanced the growth attributing characters followed by two irrigations at 30 DAS and 55 DAS. Plant height in treatment IR₁ (30 DAS) was not significantly influenced due to different irrigation frequencies. Data pertaining to plant height is given in Table 2.

The highest plant height was recorded with treatment F₃ (RDF + foliar spray of Zn @ 0.5% and B @ 0.2% at 30-35 DAS and 40-45 DAS). Which proved significantly superior over all other treatments like F₀ (RDF + control), F₁ (RDF + Zn @ 0.5% at 30-35 DAS and 40-45 DAS) and F₂ (RDF + foliar spray of B₀ @ 0.2% at 30-35 DAS and 40-45 DAS) at all the dates of observation (Table 2). Thereseearch also confirms to the findings of **Hamouda *et al.* (2018)** and **Karimunnisa *et al.* (2021)**. Application of treatment F₃(RDF + foliar spray of Zn @ 0.5% and B @ 0.2% at 30-35 DAS and 40-45 DAS) significantly produced a greater number of secondary branches plant⁻¹ than control (Table 3). Similar results were also reported by **Verma *et al.* (2018)** and **Karimunnisa *et al.* (2021)**.

Table 2: Effect of irrigation frequencies and micronutrients spray on Plant height (cm) of yellow sarson at different stages of crop growth

| Treatment | Plant height (cm) | | | | |
|-----------------------------|-------------------|--------|---------|---------|---------|
| | 20 DAS | 40 DAS | 60 DAS | 80 DAS | 100 DAS |
| Irrigation frequency | | | | | |
| IR ₁ | 6.388 | 35.336 | 96.912 | 102.505 | 107.058 |
| IR ₂ | 6.412 | 35.305 | 101.628 | 106.210 | 113.508 |
| IR ₃ | 6.435 | 35.343 | 101.727 | 106.658 | 118.950 |
| S.E. (d)± | 0.160 | 0.607 | 1.178 | 1.735 | 1.886 |
| C.D. (5%) | N.S. | N.S. | 3.253 | 4.791 | 5.376 |

| Micronutrient levels (Zn & Bo) | | | | | |
|---|-------|--------|---------|--------|---------|
| F ₀ | 6.367 | 32.187 | 96.167 | 100.94 | 106.517 |
| F ₁ | 6.400 | 34.170 | 98.677 | 103.99 | 111.073 |
| F ₂ | 6.440 | 36.550 | 101.643 | 106.72 | 115.267 |
| F ₃ | 6.463 | 38.404 | 103.870 | 108.84 | 119.830 |
| S.E. (d)± | 0.264 | 0.984 | 1.178 | 1.851 | 2.362 |
| C.D. (5%) | N.S. | 2.068 | 2.985 | 3.890 | 5.000 |
| F(IR) | | | | | |
| S.E.(d)± | 0.394 | 1.480 | 2.409 | 3.341 | 4.090 |
| C.D. (5%) | N.S. | N.S. | N.S. | N.S. | N.S. |
| IR(F) | | | | | |
| S.E.(d)± | 0.458 | 1.705 | 2.461 | 3.206 | 4.013 |
| C.D. (5%) | N.S. | N.S. | N.S. | N.S. | N.S. |

Three irrigations produced tallest plant height at harvest stage over other treatments. A significant improvement in the plant height was observed with increasing the irrigation frequencies i.e., one irrigation to three irrigation in treatments (Table 2). Water is the chief metabolic constituent of plant body and increasing the irrigation frequencies increased the plant metabolic activity which significantly affect the plant height. The more water availability with three irrigations enabled the plants to grow taller than other irrigation frequencies at all the stages. Similar result was also reported by **Tyagi and Upadhyay 2017**, **Barick et al. (2020)** and **Yadav et al., (2021)**.

Three irrigations significantly increased the number of secondary branches per plantas compared to other irrigation frequencies (Table 3) The increased growth as a result of high-water potential in plants produces higher number of branches. The similar results were also reported by **Duala et al. (2013)** and **Yadav et al. (2021)**.

Table 3: Effect of irrigation frequencies and micronutrients spray on Number of secondary branches plant⁻¹ of yellow sarson crop at different crop growth stages.

Comment [U2]:

| Treatment | Number of secondary branch plant ⁻¹ | | |
|---|--|--------|---------|
| | 60 DAS | 80 DAS | 100 DAS |
| Irrigation frequency | | | |
| IR ₁ | 8.405 | 9.557 | 9.608 |
| IR ₂ | 9.065 | 10.44 | 10.558 |
| IR ₃ | 9.093 | 10.833 | 10.928 |
| S.E.(d)± | 0.205 | 0.279 | 0.172 |
| C.D. (5%) | 0.567 | 0.769 | 0.489 |
| Micronutrients levels (Zn & B) | | | |
| F ₀ | 8.383 | 9.433 | 9.517 |
| F ₁ | 8.760 | 10.210 | 10.363 |
| F ₂ | 8.790 | 10.600 | 10.673 |
| F ₃ | 9.030 | 10.863 | 10.903 |
| S.E. (d)± | 0.181 | 0.262 | 0.216 |
| C.D. (5%) | 0.379 | 0.550 | 0.458 |
| F(IR) | | | |
| S.E. (d)± | 0.365 | 0.508 | 0.375 |
| C.D. (5%) | N.S. | N.S. | N.S. |
| IR(F) | | | |
| S.E. (d)± | 0.313 | 0.453 | 0.367 |
| C.D. (5%) | N.S. | N.S. | N.S. |

The days taken 50% siliqua initiation was significantly influenced by irrigation treatments. The maximum number of days counted was recorded with treatment IR₃ which was followed by treatment IR₂ and treatment IR₁ (Table 4)

Table 4: Effect of irrigation frequencies and micronutrients spray on Days taken 50% siliqua initiation of yellow sarson.

| Treatment | Days taken 50% siliqua initiation |
|------------------------------|-----------------------------------|
| Irrigation frequency | |
| IR ₁ | 74.430 |
| IR ₂ | 80.510 |
| IR ₃ | 81.065 |
| S.E.(d) ± | 1.261 |
| C.D (5%) | 3.595 |
| Micronutrients levels | |
| F ₀ | 81.440 |
| F ₁ | 79.350 |
| F ₂ | 77.697 |
| F ₃ | 76.187 |
| S.E.(d) ± | 1.623 |
| C.D. (5%) | 3.436 |
| F(IR) | |
| S.E.(d)± | 2.811 |
| C.D. (5%) | N.S. |
| IR(F) | |
| S.E.(d)± | 2.742 |
| C.D. (5%) | N.S. |

Effect of irrigation frequencies and micronutrients spray on yield of Mustard

The maximum number of siliqua plant⁻¹ increased significantly with treatment F₃ (RDF + foliar spray of Zn @ 0.5% and B @ 0.2% at 30-35 DAS and 40-45 DAS). These results confirm with the findings of **Rao et al. (2006)** and **Karimunnisa et al. (2021)**. Application of micronutrient also significantly increased the number of seeds siliqua⁻¹ up to application of F₃ (RDF + foliar spray of Zn @ 0.5% and B @ 0.2% at 30-35 DAS and 40-45 DAS) which was significantly superior to F₀ (RDF + control), F₁(RDF + Zn @ 0.5% at 30-35 DAS and 40-45 DAS) but remain at par with and F₂ (RDF + foliar spray of B @ 0.2% at 30-35 DAS and 40-

45 DAS). The maximum value of test weight was also obtained with the application of treatment F₃ (RDF + foliar spray of Zn @ 0.5% and Bo @ 0.2% at 30-35 DAS and 40-45 DAS) which is significantly superior over F₀ (RDF + control) and F₁(RDF + Zn @ 0.5% at 30-35 DAS and 40-45 DAS) but at par with F₂ (RDF + foliar spray of B @ 0.2% at 30-35 DAS and 40-45 DAS). This might be attributed to the increased translocation of photosynthates towards seed resulting in the formation of bold seeds (**Karimunnisa et al. (2021)**)

Application of treatment F₃ (RDF + foliar spray of Zn @ 0.5% and B @ 0.2% at 30-35 DAS and 40-45 DAS) significantly increased the number of siliqua plant⁻¹, length of siliqua, number of seeds siliqua⁻¹ and 1000 seed weight (Table 5), over treatment F₀ (RDF + control), treatment F₁ (RDF + Zn @ 0.5% at 30-35 DAS and 40-45 DAS) and treatment F₂(RDF + foliar spray of B @ 0.2% at 30-35 DAS and 40-45 DAS).

Table 5: Yield attributes of yellow sarson as influenced by irrigation frequencies and micronutrients spray

| Treatment | Siliquae plant ⁻¹ | Siliqua length (cm) | Seed Siliqua ⁻¹ | Test weight (g) |
|-----------------------------|------------------------------|---------------------|----------------------------|-----------------|
| Irrigation frequency | | | | |
| IR ₁ | 294.045 | 6.695 | 35.707 | 3.808 |
| IR ₂ | 302.888 | 6.877 | 37.992 | 4.052 |
| IR ₃ | 309.015 | 7.032 | 41.865 | 4.225 |
| S.E.(d)± | 3.700 | 0.057 | 0.658 | 0.056 |
| C.D. (5%) | 10.214 | 0.158 | 1.876 | 0.155 |
| Micro nutrient level | | | | |
| F ₀ | 287.657 | 6.543 | 35.280 | 3.863 |
| F ₁ | 300.347 | 6.813 | 37.110 | 3.983 |
| F ₂ | 307.793 | 7.000 | 39.560 | 4.083 |
| F ₃ | 312.133 | 7.117 | 42.126 | 4.183 |
| S.E.(d)± | 4.512 | 0.072 | 0.805 | 0.082 |
| C.D. (5%) | 9.482 | 0.151 | 1.704 | 0.172 |

Comment [U3]:

| F(IR) | | | | |
|-----------|-------|-------|-------|-------|
| S.E.(d)± | 7.609 | 0.120 | 1.394 | 0.128 |
| C.D. (5%) | N.S. | N.S. | N.S. | N.s. |
| IR(F) | | | | |
| S.E.(d)± | 7.816 | 0.125 | 1.375 | 0.141 |
| C.D. (5%) | N.S. | N.S. | N.S. | N.S. |

The length of siliqua (cm) was significantly influenced by irrigation treatments. The highest length of siliqua was recorded with treatment IR₃ (7.03) which was found significantly higher over treatment IR₁ (6.69) but remained at par with the treatment IR₂ (6.87). The effect of micronutrient on siliqua length (cm) was significant. The highest siliqua length was recorded with treatment F₃ (7.11) which was significantly higher over control (6.54) and treatment F₁ (6.81) but remained at par with treatment F₂ (7.00). The interaction effect of irrigation X micronutrient was found non-significant but interaction of IR₃ X F₃ produced highest siliqua length.

Summary and Conclusion

Based upon the results of the present investigation the following conclusions are drawn: it may be concluded that highest seed yield, water use and economics were obtained with three irrigations and Zn @ 0.5% and B @ 0.2% at 30-35 DAS and 45-50 DAS. It may be advised that the application of irrigations to yellow sarson (*Brassica rapa*) at 30 DAS, 55 DAS and 90 DAS were found best for getting maximum yield. If two irrigations are available, it should be applied at 30 DAS and 55 DAS for obtaining higher yields and water use efficiency. According to the results obtained from this research it can be recommended that that application of micronutrient F₃ (Zn @ 0.5% and B @ 0.2% at 30-35 DAS and 45-50 DAS) is best for getting maximum yield.

Comment [U4]: Check this conclusion its coherency with abstracts

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Comment [U5]:

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