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***Short Communication***

# Effect of irrigation levels on growth and yield of different *Brassica* species under natural and conventional farming

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## Abstract

**A field trial was conducted during *rabi* season of 2020-2021 at Water Management Farm, CSKHPKV, Palampur to find out the effect of irrigation levels and management practices on growth and yield of different *Brassica* species. The experiment was laid out in split plot design with two irrigation regimes *viz.* irrigation at 30 days after sowing (DAS) and at flowering (two irrigations) and irrigation at pre-sowing, 30 DAS and at flowering (three irrigations) in main plots, and combinations of three *brassica* species *viz. Brassica oleracea* 'KBS 3', *Brassica juncea* 'RCC 4' and *Brassica napus* 'GSC 7' and two management practices viz. conventional and natural farming in sub plots. The results revealed that application of three irrigations significantly increased the plant height, dry matter accumulation, seed and stover yield of *Brassica* species as compared to two irrigations. *Brassica oleracea* 'KBS 3' outperformed all other *Brassica* species where as conventional management proved superior over natural farming on mean basis. However, application of two irrigations in *Brassica oleracea* 'KBS 3' under conventional management, being at statistically at par with three irrigations was found best in terms of seed yield besides saving precious irrigation water.**

**Key words**: *Brassica* species, Conventional farming, Irrigation, Natural farming, Yield

In India, rapeseed-mustard is an important oilseed crop, grown in an area of 6.23 million hectares with total production of 9.34 million tonnes and productivity of 1499 kg $ha^{-1}$ (AICRP 2019-2020). In Himachal Pradesh, three major oilseed crops namely sesame, linseed and rapeseed-mustard, are being cultivated in an area about 18,000 hectares. Rapeseed-mustard has shown an increase in area as well as production and productivity over time (Prasad and Kumari 2015) and since hybrid or high yielding varieties give higher yield (Thakur *et al.* 2012), a need arises to identify a suitable variety for the particular area to be cultivated. As rapeseed-mustard has low water requirement (240–400 mm) and fits well in the rainfed cropping systems, this crop needs to be evaluated for its sustainability as an alternative option for water and nutrient intensive crop like wheat. Though grown mainly as a rainfed crop, rapeseed-mustard responds to irrigation particularly as pre-sowing irrigation which enhances the seed germination and plant stand and consequently the seed yield (Shine and Guruprasad 2012).

As rapeseed mustard is primarily cultivated in temperate regions with varying climatic and edaphic conditions, a careful selection of suitable species or variety is thus vital for enhancing productivity and resource utilization and crop quality. The different species within a genus differ in their water use efficiency by virtue of different morphological and metabolic changes in response to the stress. The agronomic management practices like date of planting, varietal selection and nutrient management help in attaining the optimum productivity. Being presently grown under marginal conditions, the concept of natural farming, with benefits of resource conservation, can be an alternative way of production

for resource-poor farmers of the state. Under limited water availability, deficit/limited irrigation has been used to improve water use efficiency without reducing the crop yield. Information on response of different oilseed *brassica* species to varying irrigation levels under different farming practices is limited. Hence the present investigation was undertaken to evaluate the performance of different *Brassica*s species under varying irrigation and management practices.

The trial was conducted at the Water Management Research Farm of the Department of Soil Science, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur (32° 06′ 39.1′′ N latitude and 76° 32′ 10.5′′ E longitude and at an elevation of 1290 m above mean sea level). The area represents the mid hills sub humid zone of Himachal Pradesh and is characterized by mild summers and cool winters. The total rainfall recorded during the crop season was 342.6 mm while effective rainfall as calculated by CROPWAT 8.0 software was 233.3 mm. The soil of the experimental field was acidic in reaction (pH 5.3), medium in available nitrogen (263.6 kg $ha^{-1}$), high in available phosphorus (33.4 kg $ha^{-1}$) and medium in available potassium (242.6 kg $ha^{-1}$).

The experiment consisted of two irrigation levels viz. irrigation at pre-sowing, 30 days after sowing (DAS) and at flowering ($I_2$), and irrigation at 30 DAS and at flowering ($I_1$), three *brassica* species viz. *Brassica oleracea* 'KBS 3', *Brassica juncea* 'RCC 4' and *Brassica napus* 'GSC 7' and two management practices *viz*. conventional and natural farming system. The experiment was laid out in split plot design with three replications. For conventional system, the recommended dose of fertilizer was 120: 60: 40 kg NPK $ha^{-1}$for *Brassica napus* and 60: 40: 40 kg NPK $ha^{-1}$for *Brassica juncea* and *Brassica oleracea*. The recommended dose of phosphorus and potassium was supplied through SSP (16% $P_2O_5$) and MOP (60% $K_2O$), respectively and the entire quantity of these fertilizers was applied at the time of sowing. Nitrogen was applied through urea (46% N), ½ as basal application and the remaining½ in two equal splits i.e. 30 DAS and at flowering. For the natural management system, powdered *ghajeevamrit* was applied and incorporated in the soil @ 395 kg $ha^{-1}$at the time of sowing. Seeds were treated with *beejamrit* and dried under the shade for 30 minutes before sowing. Freshly prepared *Jeevamrit* was used and sprayed regularly at 21 days intervals. The total nutrients applied in natural management were N: 9.33, P:3.67 and K:3.44 kg $ha^{-1}$.

The observations were recorded for plant height, dry matter accumulation at 30, 60 and 90 DAS and harvest, seed yield and stover yield. The data obtained was statistically analyzed as per the procedure outlined by Gomez and Gomez (1984). The critical difference (CD) was estimated for parameters with significant impacts at the 5% probability level.

The data pertaining to the effect of irrigation levels and management practices on periodic plant height and periodic dry matter accumulation of different *Brassica* species is presented in Table 1.

**Table 1. Effect of irrigation levels and management practices on plant height and dry matter accumulation of different brassica species**

| Treatment | Plant height (cm) | | | | Dry matter accumulation (g $m^{-2}$) | | | |
|---|---|---|---|---|---|---|---|---|
| **Irrigation levels** | **30 DAS*** | **60 DAS** | **90 DAS** | **At harvest** | **30 DAS** | **60 DAS** | **90 DAS** | **At harvest** |
| $I_1$ | 9.2 | 22.3 | 68.8 | 107.6 | 14.4 | 129.9 | 265.5 | 400.1 |
| $I_2$ | 9.6 | 24.8 | 74.1 | 114.3 | 16.4 | 138.9 | 285.9 | 435.2 |
| **CD (P=0.05)** | **NS** | **2.4** | **4.9** | **6.4** | **1.9** | **8.9** | **12.2** | **34.6** |
| ***Brassica* species** | | | | | | | | |
| $B_1$- *Brassica oleracea* 'KBS 3' | 10.5 | 26.4 | 80.5 | 119.1 | 18.7 | 162.3 | 332.0 | 461.1 |
| $B_2$- *Brassica juncea* 'RCC 4' | 9.4 | 23.2 | 70.7 | 109.8 | 16.1 | 127.8 | 270.2 | 420.5 |
| $B_3$- *Brassica napus* 'GSC 7' | 8.3 | 21.1 | 63.2 | 103.9 | 11.3 | 113.1 | 224.8 | 371.3 |
| **CD (P=0.05)** | **0.6** | **1.4** | **2.4** | **2.0** | **1.0** | **3.9** | **6.5** | **9.8** |
| **Management practices** | | | | | | | | |
| $M_1$-Conventional management | 10.9 | 27.8 | 89.6 | 134.2 | 20.2 | 178.9 | 342.8 | 472.8 |
| $M_2$- Natural management | 7.9 | 19.3 | 53.3 | 87.6 | 10.6 | 90.0 | 208.6 | 362.5 |
| **CD (P=0.05)** | **0.5** | **1.2** | **1.9** | **1.7** | **0.8** | **3.2** | **5.3** | **8.0** |

**$I_1$**: Irrigation at 30 DAS and flowering, **$I_2$**: Irrigation at pre-sowing, 30 DAS and flowering; **DAS***: Days after sowing

Application of three irrigations ($I_2$) resulted in significantly taller plants and higher dry matter accumulation of brassica species at all the growth stages except 30 DAS as compared to the application of only two irrigations ($I_2$). The increase in plant height and dry matter with three irrigations was due to the additional pre-sowing irrigation which helped in better seed germination and root establishment leading to good crop establishment right from the beginning (Chen *et al.* 2019). Larger root biomass could have attributed to more nitrogen and water uptake from the soil and supported a greater rate of above ground biomass production (Wasson *et al.* 2012). The results are also supported by studies of Piri *et al.* (2011) on Indian mustard and Verma *et al.* (2014) on rapeseed-mustard.

Among different *Brassica* species, highest plant height and dry matter accumulation were recorded for *Brassica oleracea* 'KBS 3' followed by *Brassica juncea*'RCC 4' and *Brassica napus* 'GSC 7' at all the stages of observation. The comparative taller plants of'KBS 3' were due to its inherent genetic character and its higher adaptability and suitability for this region. As dry matter accumulation is positively correlated with plant height therefore, significantly higher dry matter accumulation was also recorded for *Brassica oleracea* 'KBS 3' among all *Brassica* species. These parameters were also significantly influenced by different management practices and *Brassica* species under conventional management system recorded significantly higher values of these parameters as compared to natural management system at all the growth stages. Easy and adequate availability of the vital plant nutrients under conventional management system which plants readily absorb during their vegetative phase resulted in better crop growth and consequently significantly taller plants (Thanki *et al*. 2004 and Adhikari 2009). Under conventional management system, readily available forms of nutrients applied from chemical fertilizers in sufficient amount enhanced the plant growth and height, there by resulting in higher dry matter accumulation. The results are in confirmatory with that of Sahu *et al.* (2011).

On mean basis, application of three irrigations significantly increased the seed and stover yield of *Brassica* species over two irrigations (Table 2). Clearly, additional pre-sowing irrigation enhanced the seed yield by 16.1 per cent and stover yield by 10.3 per cent. Better root growth as a result of pre-sowing irrigation would have increased the above ground biomass production (Yang 2012 and Zhang *et al.* 2009) and consequently the seed and stover yield. Among the different *Brassica* species, highest seed yield was recorded for *Brassica oleracea* 'KBS 3' followed by *Brassica juncea* 'RCC 4' and *Brassica napus* 'GSC 7'. With respect to management practices, significantly higher seed yield was recorded under conventional management system as compared to natural management. The increase in seed and stover yield under conventional management was 56.3 and 51.8 per cent, respectively over natural system and can be partly attributed to increased availability of N, P and K under conventional management practices where these nutrients were provided through application of chemical fertilizers.

**Table 2. Effect of irrigation levels and management practices on seed and stover yield of different brassica species**

| **Treatment** | **Yield (q ha$^{-1}$)** | |
|---|---|---|
| **Irrigation levels** | **Seed yield (q ha$^{-1}$)** | **Stover yield (q ha$^{-1}$)** |
| $I_1$ | 8.54 | 27.92 |
| $I_2$ | 9.92 | 30.80 |
| **CD (P=0.05)** | **0.92** | **1.47** |
| ***Brassica* species** | | |
| $B_1$- *Brassica oleracea* 'KBS 3' | 10.79 | 34.46 |
| $B_2$- *Brassica juncea* 'RCC 4' | 9.12 | 29.17 |
| $B_3$- *Brassica napus* 'GSC 7' | 7.78 | 24.45 |
| **CD (P=0.05)** | **0.35** | **0.85** |
| **Management practices** | | |
| $M_1$ Conventional management | 11.26 | 35.40 |
| $M_2$- Natural management | 7.20 | 23.32 |
| **CD (P=0.05)** | **0.29** | **0.69** |

The interaction effect between irrigation levels, *Brassica* species and management practices was found to be significant for dry matter accumulation at harvest, seed and stover yield (Table 3). Application of two irrigations in *Brassica oleracea* 'KBS 3' under conventional management was found to be statistically at par with three irrigations in terms of dry matter accumulation at harvest and seed yield. Highest stover yield was recorded with *Brassica oleracea* 'KBS 3' when grown under conventional management system with three irrigations. *Brassica oleracea* 'KBS 3' raised under conventional management system with two irrigation regimes proved to statistically at par with *Brassica juncea* 'RCC 4' under conventional management system with three irrigation regimes in terms of seed and stover yield. During crop growth, supply of nutrients and availability of assimilates for pod set and seed filing are decisive factors which affect the yield. For Indian mustard, the sink lies in the siliqua and seeds and hence, under supply of N this greater translocation of photosynthates from leaf to siliqua resulted in robust siliqua and seed formation (Hocking *et al.*1997). Moreover, adequate supply of moisture favorably improved nutrient uptake and translocation which ultimately increased the yield. It was found that the enhanced moisture supply has increased the nitrogen availability to the plant throughout the crop growth, which finally resulted in high seed yield ($I_2B_1C_1$).

**Table 3. Interaction effect of irrigation levels, *brassica* species and management practices on dry matter accumulation at harvest, seed and stover yield**

| Treatments | Dry matter accumulation at harvest (g $m^{-2}$) | Seed yield(kg $ha^{-1}$) | Stover yield(kg $ha^{-1}$) |
|---|---|---|---|
| $I_1B_1C_1$ | 508.9 | 1231.7 | 3814.8 |
| $I_1B_1C_2$ | 382.2 | 863.0 | 2850.5 |
| $I_1B_2C_1$ | 457.3 | 1071.0 | 3369.1 |
| $I_1B_2C_2$ | 358.4 | 622.0 | 2317.4 |
| $I_1B_3C_1$ | 403.3 | 863.0 | 3014.2 |
| $I_1B_3C_2$ | 290.4 | 473.3 | 1387.6 |
| $I_2B_1C_1$ | 533.2 | 1335.7 | 4173.3 |
| $I_2B_1C_2$ | 420.0 | 885.7 | 2945.9 |
| $I_2B_2C_1$ | 495.7 | 1153.7 | 3637.9 |
| $I_2B_2C_2$ | 370.6 | 800.7 | 2345.0 |
| $I_2B_3C_1$ | 438.3 | 1100.7 | 3233.2 |
| $I_2B_3C_2$ | 353.3 | 674.7 | 2145.6 |
| **CD** | **36.7** | **104.8** | **201.8** |

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