# Effect of different sowing dates and establishment methods on growth, yield and economics of Mustard (*Brassica Juncea* L.)


## Abastract

Adaption of FIRBS and date of seeding are one of the important input for crop production particularly for rabi crop. Late harvesting of rice crop severely affected the yield of rice crop. Early planting through raised bed of mustard can compensate the late planting at least 10-15 days. Under this circumstance the use of Raised bed planter along with timely sowing of mustard can produce higher yield. An adaptive research trail was conducted the rabi season of 2020-21 and 2021-22 at farmers field in Jamui district to study the effect of different sowing dates and establishment methods of mustard crop. The trail was conducted in Factorial Randomized Block Design with two method of sowing and three dates of sowing. The growth characters like plant height, leaf area index, no. of primary branches plant$^{-1}$, no. of secondary branch plant$^{-1}$, no. of silique plant$^{-1}$, no. of seeds silique$^{-1}$. Test weight, grain and straw yield was influenced significantly due to different sowing dates and sowing methods. Higher plant height at harvest stage (160 cm) , leaf area index at 60 DAS (3.3), no. of primary branches plant$^{-1}$ (4.0 ), no. of secondary branch plant$^{-1}$ (7.8 ), no. of silique plant$^{-1}$ (292.4 ), no. of seeds silique$^{-1}$ (9.7 ), test weight (3.8 ), grain (10.1 q ha$^{-1}$ ) and straw yield (22.4 q ha$^{-1}$ ) was recorded when the crop was sown on 05$^{th}$ November during both years. Whereas the mustard crop sown on FIRBS recorded highest growth attributes, yield components and seed yield (12.5 q ha$^{-1}$) over the conventional method. Highest benefit cost ratio was calculated with Furrow Irrigated Raised Bed system (2.0 ) as compared to all other treatments.



**Key words:** Furrow Irrigated Raised Bed System, Conventional Method, Cost of cultivation, B:C Ratio.




**Introduction:**

Mustard is the second most important edible oil seed crop. Mustard oil is used as cooking oil and also condiments, medicine and industrial purpose. The estimated area, production and yield of rapeseed-mustard in the world was 36.59 million hectares m. ha, 72.37 million tonnes (mt) and

1980 kg ha-1, respectively, during 2018-19. Globly, India account for 19.8 percent and 9.8 percent of the total acerage and production (USDA).

During the last eight years, there has been a considerable increase in productivity from 1840 kg ha-1 in 2010-11 to 1980 kg ha$^{-1}$ in 2018-19 and production has increased from 61.64 mt. in 2010-11 to 72.42 mt in 2018-19. Soybean, groundnut and rapeseed-mustard are the major oilseed crops in India contributing nearly 84 % and 88% to its total acerage and production, respectively (Average of 2014-15 to 2018-19). The seeds are highly nutritive containing 38-57% erucic acid, 5-13% linoleic acid and 27% oleic acid (Avinash Patel *et al*.,). Rapeseed-mustard crops in India are grown in diverse agro climatic conditions ranging from north – eastern/north western hills to down south under irrigated/rainfed, timely/late sown, saline soils and mixed cropping. Indian mustard accounts for about 75-80 % of the 6.23 m ha under these crops in the country during 2018-19 crop season. India is the third largest country in edible oil economy after USA and China. Oilseed crops, such as Soybean, Mustard, Groundnut and Sunflower are the major source of edible oils (Uikey, 2017). In India, total oilseeds production is 320.83 lakh tons, and the contribution of mustard is 79.77 lakh tons rank second after soyabean (137.94 lakh tons) in the India’s economy. Indian mustard is predominantly cultivated in the states of Rajsthan, UP, Haryana, Madhya Pradesh, Gugrat, West Bengal, Assam, Bihar and Punjab (DES 2017). Indian mustard is temperate as well as tropical climate crop suited and cool weather conditions to attain satisfactory growth parameters. Dry matter accumulation is the important parameter for obtained better growth and yield attributes and yields in the crop which mostly impact by the adopting changing management viz. sowing dates and soil fertility management practices under changing the climate (Singh *et al*., 2014). Rpeseed-Mustard is considerably sensitive to weather as evidenced from the variable response to different dates of sowing (Kumar *et al*., 2007). Indian mustard is highly sensitive to climate change and soil fertility (Mandal and Sinha, 2004). Time of sowing is very important for mustard oroduction (Mondal et al.,1999). Optimum sowing time plays an important role to fully exploit the genetic potential of a variety as it provides optimum growth conditions such as temperature, light humidity and rainfall (Iraddi, 2008). The growth phase of the crop should synchronize with optimum environmental conditions for better expression of growth and yield. Indian mustard is highly sensitive to climate change and soil fertility (Mandal and Sinha, 2004). Sowing time is a nomonetary input for optimizing the maximum dry matter accumulation and to provide most congenial conditions for maximum light interception and the best utilization of moisture and nutrients to the better plant growth and seed yield (Pattam, 2017 Singh *et al*., 2011, Meena and Yadav 2015). India occupies the third position in rapeseed and mustard production in the world after Canada and China. In India, during 2013-14, the area of rapeseed-mustard was 6.5 million ha. with the production of 7.8 million tones and productivity 1208 kg ha-19Annonymous 2013-14). It is a winter (Rabi) season crop that requires relatively cool temperature, a fair supply of soil moisture during the growing season and a dry harvest period (Banerjee *et al*., 2010). In Bihar, the area under mustard cultivation is 75,240 ha. area with production of 89.34 mt and productivity 1187 kg ha-1. Bihar ranked ninth among the states, in rapeseed-mustard production, with a growth rate of 7.34% during the eighties whereas Rajasthan state with top ranked. It is the most important crops among oilseeds in terms of both area and production (DES, Govt. of Bihar 2019-20). The productivity of mustard is lower than national average. Among the several reasons responsible for low productivity of mustard, grown in residual moisture condition, photo-thermo sensitivity nature, non-adoption of good agronomic practices like optimum date of sowing and sowing method/establishment method are most important. The optimum sowing time is one of the most important nonmonetary input for increasing dry matter accumulation and to provide most favourable atmosphere for better light interception and the maximum utilization of nutrients and moisture which helps healthier plant growth and seed yield of crops. Rapeseed-mustard is noticeably sensitive to weather as shown from the variable response to to different sowing dates (Kumar *et al*., 2010). One-month delay in sowing from mid-October resulted in loss of 40 % in seed yield (Lallu *et al*., 2010). The secret of boosting its yields mainly lies with suitable sowing date (Kithan *et al*., 2020). Optimum sowing date and sowing method much affected the yield and yield parameters. Therefore, optimum sowing dates and sowing method be a better alternative to minimize yield loss in mustard. Sowing method like furrow irrigated raised bed system (FIRBS) is a water-saving technology, which saves 30-40% water depending up on the soil type. In addition to water saving, this technology also saves Nitrogen by about 25% due to higher nitrogen-use efficiency. In this technology, after preparation of land all activities, viz. bed formation, placement of fertilizer and sowing are done in single operation. It is suitable for seed production also because of bolder grain and easier rouging. In situation where sowing can be delayed due to pre-sowing irrigation, dry seeding can be done on raised beds followed by irrigation immediately after seeding (Sharma *et al*. 2004).

Therefore, present investigation was conducted to study the "Effect of different sowing dates and establishment methods on growth, yield and economics of Mustard (*Brassica Juncea* L.).

**Materials and Methods:**

An adaptive research trail was conducted at farmer's field in Jmaui district during winter season of 2020-21 and 2021-22 under Climate Resilient Agriculture Programme. The climate of Jamui district is sub tropical, semi-arid with annual rainfall 1110 mm. The experiment was laid out in factorial randomized block design with treatment comprising three dates of sowing viz. $30^{th}$ October $15^{th}$ November and $30^{th}$ November and two different sowing methods viz. Furrow Irrigated Raised Bed System and Conventional Tillage each replicated five times. The soil of experimental field was sandy loam in texture, medium in organic carbon (0.62%), available nitrogen (220.2 kg $ha^{-1}$), phosphorus (9.7 kg $ha^{-1}$) and potassium $K_2O$ (72.2 kg $ha^{-1}$) and having pH 6.2. The total rainfall recorded during crop period were 16.7 mm and 15.3 mm, minimum temperature ranged 3.5 to 16.2 $^0$C and maximum temperature recorded ranged between 23.0 to 34.2 $^0$C during winter 2020-21 and 2021-22 respectively. Each trail comprised one-acre land area under two tillage practices (FIRBS and FP) and three sowing dates. In FIRBS, one row was sown on the top of bed at proper distance of 60 X 60 cm (line to line) by Raised planter machine in pulverized soil. In FP land was prepared by two ploughing and planking followed by pre sowing irrigation and seeds was broadcasted in the field by using 2.5 kg ha-1 seed rate, while in FIRBS only two kg seed per ha. The crop variety Pusa Mustard -30 was sown in all treatments in both the years. The crop was fertilized with recommended dose 80:60:40. Half amount of Nitrogen and full dose of phosphorus and potash were applied as basal and rest half of nitrogen was top dressed after 30-35 DAS. The source of fertilizer was DAP, Urea and MOP for Nitrogen, Phosphorus and Potash respectively. Two irrigation were given first irrigation at 30 – 35 DAS and second irrigation at flowering stage of crop period. Other management practices were adopted as per recommended of the crop. Observations regarding plant height (cm), Leaf Area Index (LAI), No. of primary branches and No. of secondary branches were taken at 30, 60 and 90 DAS interval.

**Plant Height:**

Plant height was recorded by selecting 5 random plants from each net plot tagged and height of plant was measured with the help of meter scale from soil surface to apex of the plant at

30,60, 90 DAS and at harvest stage of the crop and mean value from all the recorded data was worked out.

**Leaf Area Index:**

Similarly, the leaf area of five plants was measured by automatic leaf area meter at 30, 60 and 90 DAS of the crop and leaf area index was calculated by the following formula:

$$\textbf{Leaf Area Index} = \frac{\boldsymbol{Leaf\ Area}}{\boldsymbol{Ground\ Area}}$$

**Leaf Area Index (LAI) = leaf area/ground area**

**No. of primary and Secondary branches:**

Five randomly selected plants tagged for plant height were used for plant height were also used for counting the number of primary and secondary branches and average was worked out.

**No. of Siliqua plant$^{-1}$:**

Number of siliqua counted from five randomly tagged plants in each net plot. Counted the total numbers of siliquae of all five plants and averaged value were recorded.

**Number of Seeds Siliquae$^{-1}$ :**

Five randomly selected siliqua, were threshed and seeds obtained and counted and finally to take the average value was recorded.

**Grain Yield :**

Harvesting of individual plot was done at physiological maturity when siliquae turned brownish. From the individual plot, the net plot area was harvested and produce was sun dried for few days at threshing floor after proper tagging. After drying the crop was threshed by wooden sticks and cleaned separately. The final weight was recorded in kg per net plot and finally converted into quintal per ha.

**Stover Yield :**

Whole biomass was weighted just before threshing. After removing of grain. Stover yield was recorded by subtracting seed weight from total biomass.

**Test weight (g) :**

From the representative sample of 1000 healthy seeds were counted from the produce of each net plot and weighed. Weighted of 1000 seeds were recorded in gram.

**Harvest Index :**

The ratio of economics yield and biological yield was computed by using following formula (Donald 1962).

$$\text{Harvest Index} = \frac{Economic\ yield}{Biological\ yield} X100$$

Data were recorded from an area enclosed in the quadrate of 0.5 $m^2$ randomly selected at three places in each treatments.

**Result and Discussion**

**Plant Height:** The plant height of mustard recorded at various intervals, differed significantly among the sowing methods and sowing dates. In general plant height was highest in Furrow Irrigated Raised Bed System (FIRBS) than Conventional Method (CT) at all crop growth stages. Plant height was found to be higher with crop sown on $05^{th}$ Nov. which was at par with $15^{th}$ Nov. and significantly higher than $25^{th}$ Nov.

An appraisal of table 1 clearly revolves that pooled value in Treatment $T_1$(FIRBS) recorded significantly higher plant height viz. 24.2 cm,73.5 cm, 75.6 cm and 165.4 cm at 30 DAS, 60 DAS, 90 DAS and at harvest stages respectively which was greater than Conventional method at all stages. Different sowing dates had no significant influence on plant height at 30 DAS which might be due to similar growth pattern at initial growth period whereas at 60 DAS, 90 DAS and at harvest stage the Treatment $S_1$ ($05^{th}$ Nov. sowing date) significantly higher plant height as compared to Treatment $S_2$ ($15^{th}$ Nov. sowing date) and S3 ($25^{th}$ Nov. sowing date). It might be due to longer crop period. Similar finding was reported by Aziz *et. al* (2011), Bazzaz *et. al*. (2020) and Sandip Kr. De *et. al*. (2021).

**Leaf Area Index:** A perusal of table 1 clearly shows that Leaf Area Index (LAI) differed significantly at 60 DAS and 90 DAS in FIRBS as compared to Conventional method. Whereas at 30 DAS LAI had no significant influences on the leaf area index at 30 DAS which might be due to slower growth rate at initial crop stage. It is quite evident from the data that leaf area index increased successively till 60 DAS and 90 DAS under different sowing methods. Treatment $T_1$ (FIRBS) recorded maximum leaf area index viz. 3.8 and 3.2 at 60 DAS and 90 DAS respectively over treatment $T_2$ (Conventional Method), which might be due to higher photosynthesis and more leaf formation.

Among the different sowing dates the higher Leaf Area Index was recorded with treatment $S_1$ ($05^{th}$ Nov. sowing date) 3.3 and 3.0 at 60 and 90 DAS respectively as compared to treatment $S_2$ ($15^{th}$ Nov. sowing date) and $S_3$ ($25^{th}$ Nov. sowing date). Whereas at 30 DAS there are no Significant variation shows at 30 DAS. Delayed, sowing near about 20 – 25 days achieved lower leaf area index at all stages of mustard crop which might be due to less vegetative growth because of less favorable environmental conditions, when crop was sown to early and late late sowing conditions. Similar findings have been reported by Kumar *et. al.*, (2015) and Avinash Patel *et. al.*, (2017).

**Table 1: Plant height and leaf area index as influenced by different sowing methods and dates.**

| Treatments | Plant Height (cm) | | | | Leaf Area Index | | |
|---|---|---|---|---|---|---|---|
| | 30 DAS | 60 DAS | 90 DAS | At harvest | 30 DAS | 60 DAS | 90 DAS |
| $T_1$ - FIRBS | 24.2 | 73.5 | 75.6 | 165.4 | 1.6 | 3.8 | 3.2 |
| $T_2$ - CT | 19.5 | 62.3 | 60.8 | 150.2 | 1 | 2.7 | 2.2 |
| F- test | S | S | S | S | S | S | S |
| Sed+ | 0.16 | 0.39 | 0.54 | 0.43 | 0.077 | 0.16 | 0.11 |
| CD (P=0.5) | 0.47 | 1.15 | 1.60 | 1.28 | 0.22 | 0.47 | 0.32 |
| $S_1$ - $05^{th}$ Nov | 23.4 | 69.7 | 68.7 | 160 | 1.4 | 3.3 | 3 |
| $S_2$ - $15^{th}$ Nov | 23 | 68.5 | 64.2 | 158.2 | 1.3 | 3.2 | 2.9 |
| $S_3$ - $25^{th}$ Nov | 21.4 | 65.2 | 61.5 | 155.4 | 1.2 | 3 | 2.7 |
| F- test | S | S | S | S | S | S | S |
| Sed+ | 0.13 | 0.31 | 0.14 | 0.36 | 0.77 | 0.13 | 0.089 |
| CD (P=0.5) | 0.37 | 0.91 | 0.41 | 1.06 | 2.29 | 0.37 | 0.26 |

**Abbreviations used: CT – Conventional Tillage, DAS – Days After Sowing**

**No. of Primary & Secondary branches plant$^{-1}$:** Data pertaining to no. of primary and secondary branches plant$^{-1}$ of mustard as affected by sowing methods and date of sowing.

The no. of primary and secondary branches of Traetment $T_1$ (FIRBS) 4.2 and 10.5 significantly higher over Treatment $T_2$ (CT) 3.4 and 7 respectively. The crop sown on $05^{th}$ Nov. recorded significantly higher no. of primary and secondary branches 4 and 8.5 as compared to other sowing dates. Delayed sowing at 25$^{th}$ Nov. recorded a smaller no. of primary and secondary branches plant$^{-1}$ might be due to late sown crop faced high temperature erasure stress that ultimately decreased stand established and growth of plant finally reduced the branches. Similar findings were reported by Alam *et. al*. (2015), Bazze *et. al*. (2020) and Sandip Kr. De. *et.al*. (2021).

**No. of Siliqua plant$^{-1}$:** The Treatment $T_1$ (Furrow Irrigated Raised Bed System) recorded significantly highest silique Plant$^{-1}$ (308) over Conventional Method (272.4). In case date of sowing Treatment $S_1$ (05$^{th}$ Nov.) recorded higher no. of Siliqua Plant$^{-1}$ (302.1) over all other sowing dates treatment. Higher value might be due to early crop establishment, better biomass production and longer crop duration. Bhuiyan *et. al*. (2008), Alam *et. al*. (2015), Sandeep De. *et. al*. (2021) also reported similar finding.

**No. of Seeds Siliqua$^{-1}$:** Data with respect to no. of seeds silique$^{-1}$ as affected by method of sowing and date of sowing recorded. Significantly highest no. of seed silique-1 (12.5) was recorded with Treatments $T_1$ (FIRBS) as compared to Treatment $T_2$ (8.6). Higher no. of Seeds silique$^{-1}$ in FIRBS might be due to maintain the proper aeration and nutrition in soil solution. Mustard crop sown on Treatment $V_1$ (05$^{th}$ Nov.) was recorded significantly higher no. of seeds silique$^{-1}$ (10.4) over Treatment $V_2$ (15$^{th)}$) Nov and Traetment $V_3$ (25$^{th}$ Nov.). Higher value due to vigorous growth of crop and more supply of photosynthetic to large no. of sinks under favorable agro meteorological conditions. Similar findings reported by Bhuiyan *et. al*. (2008), Alam *et. al*. (2015), Sandeep De. *et. al*. (2021).

**Test weight:** Significantly highest test weight (4.2) was recorded with Treatment $T_1$ (FIRBS) as compared to Treatment $T_2$ (CT). Where as in different sowing dates there was no significantly variations show.

**Table 2: Growth parameters as influenced by different sowing methods and dates.**

| Treatments | No. of primary branches plant$^{-1}$ | No. of secondary branches plant$^{-1}$ | No. of Siliqua plant$^{-1}$ | No. of seeds Solique$^{-1}$ | Test wt. (g) |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| $T_1$ - FIRBS | 4.2 | 10.5 | 308.4 | 12.5 | 4.2 |
| $T_2$ - CT | 3.4 | 7 | 272.4 | 8.6 | 3.4 |
| F- test | S | S | S | S | S |
| Sed+ | 0.26 | 0.15 | 0.28 | 0.17 | 0.09 |
| CD (P=0.5) | 0.77 | 0.44 | 0.83 | 0.50 | 0.27 |
| $S_1$ - 05$^{th}$ Nov | 4 | 8.5 | 302.1 | 10.4 | 3.9 |
| $S_2$ - 15$^{th}$ Nov | 3.8 | 7.8 | 292.4 | 9.7 | 3.8 |
| $S_3$ - 25$^{th}$ Nov | 3.6 | 7.5 | 280 | 9 | 3.7 |
| F- test | S | S | S | S | NS |
| Sed+ | 0.066 | 0.12 | 0.23 | 0.14 | 0.08 |
| CD (P=0.5) | 0.18 | 0.35 | 0.68 | 0.41 | 0.23 |

**Abbreviations used: CT – Conventional Tillage**

**Grain and Straw yield:** Comparing various sowing methods, Raised Bed Planting method found to be superior for raising the mustard crop. Treatment $T_1$ (FIRBS) produced significantly highest grain and straw yield 12.5 and 26.8 q. ha$^{-1}$ respectively. The higher value of FIRBS has showed excellent performance which is 47 % higher than Conventional Method. Which is might be due to better seed germination and root proliferation, reduces the mechanical resistance to plant roots, increase soil porosity and encourage crop growth and preventation of water stagnation after irrigation results in enhancing the water use efficiency of crop. Similar finding was found with Singh Samar Pal *et. al*., (2019), Kapila Shekhwat *et. al*., (2016). Raised Bed planting records 35% of water saving and resulted in 32% higher water use efficiency (Buttler *et. al*. 2006). The crop sown on 05$^{th}$ Nov. was produced significantly higher grain and straw yield 10.1 and 22.4 q ha$^{-1}$ respectively over crop sown 15$^{th}$ and 25$^{th}$ Nov. might be attributed to higher plant height, no. of primary and secondary branches plant$^{-1}$ no. of siliqua plant$^{-1}$, no. of seeds silique$^{-1}$ and other growth parameters. Similar result was found with Mondal *et. al*., (1999), Awasthi U.D *et. al*., (2007),Aziz *et. al*., (2011) and Gawariya *et. al*., (2015).

**Harvest Index:** The Treatment $T_1$ (Furrow Irrigated Raised Bed System) has found significantly highest harvest index (31.8) as compared to Conventional method (29.9). Whereas in different sowing dates there was no significant variations showed.

**Table 3: Grain yield, Straw yield and Harvest index influenced by different sowing methods and dates.**

| Treatments | Grain Yield q ha$^{-1}$ | Straw yield q ha$^{-1}$ | Harvest Index |
|---|---|---|---|

| | | | |
|---|---|---|---|
| $T_1$ - FIRBS | 12.5 | 26.8 | 31.8 |
| $T_2$ - CT | 8.5 | 19.9 | 29.9 |
| F- test | S | S | S |
| Sed+ | 0.11 | 0.15 | 0.15 |
| CD (P=0.5) | 0.32 | 0.44 | 0.44 |
| $S_1$ - $05^{th}$ Nov | 10.1 | 22.4 | 31 |
| $S_2$ - $15^{th}$ Nov | 9.6 | 21.8 | 30.5 |
| $S_3$ - $25^{th}$ Nov | 8.8 | 20.3 | 30.2 |
| F- test | S | S | NS |
| Sed+ | 0.09 | 0.12 | 0.12 |
| CD (P=0.5) | 0.26 | 0.35 | 0.35 |

Abbreviations used: CT – Conventional Method

**Economics:** Maximum gross return (Rs. 63,150 ha$^{-1}$), net return (Rs. 41,900 ha$^{-1}$) and B:C ratio (2.0) were recorded by Furrow Irrigated Raised Bed System as compared to Conventional Method of sowing. Where as in different sowing methods on $05^{th}$ Nov. date of sowing calculated higher Maximum gross return (Rs. 48,480 ha$^{-1}$) , net return (Rs. 27,980 ha$^{-1}$) and B:C ratio (1.3) as compared to other sowing dates.

**Table 4: Economics influenced by different sowing methods and dates.**

| Treatments | Cost of cultivation Rs. ha$^{-1}$ | Gross return Rs. ha$^{-1}$ | Net Returns ha$^{-1}$ | B:C ratio |
|---|---|---|---|---|
| $T_1$ - FIRBS | 21,250 | 63,150 | 41,900 | 2.0 |
| $T_2$ - CT | 18,500 | 42,925 | 24,425 | 1.3 |
| $S_1$ - $05^{th}$ Nov | 20,500 | 51,005 | 30,505 | 1.5 |
| $S_2$ - $15^{th}$ Nov | 20,500 | 48,480 | 27980 | 1.3 |
| $S_3$ - $25^{th}$ Nov | 20,500 | 44,176 | 23,676 | 1.1 |

Abbreviations used: CT – Conventional Method

**Conclusion:**

From the above experiment, it can be concluded the different sowing methods and date of sowing significantly influenced the growth, yield and economic parameters as well as the productivity. Comparing various sowing methods, raised bed planting method found to be superior for raising the mustard crop as it maintains the proper aeration and nutrient in soil solution. The raised bed planting method plays a significant role in better seed germination and root proliferation, reduces the mechanical resistance to plant roots, increases soil porosity and encourages crop growth and prevention of water stagnation after irrigation results in enhancing the water use efficiency of crop.

## Reference


Avinash patel, A.K.Singh, Shiv Vendra Singh, Alekh Sharma, Nikhil Raghuvanshi and Avanish Kumar Singh., 2017. Effect of Different Sowing Dates on Growth and Quality of Various Indian Mustard (*Brassica juncea* L.) Varieties. *Int. J.Curr.Microbial. App.Sci*. Special Issue-**4**: 71-77.

Aziz, M.A., Chakma, R., Ahmed, M., Rahman, A.K.M.M., Roy, K., 2011. Effect of sowing dates On the growth development and yield of mustard in the hilly areas. *Journal of Experimental Biosciences* **2**(1), 33-36.

Alam, M.J., Ahmed, K.S.,Mollah, M.R.A., Tareq, M.Z. and Alam, J. (2015). Effect of planting Dates on the Yield of Mustard Seed. *Int. J. Applied Sci. Biotech*., **3**(4): 651-655.

Awasthi, U.D, Singh R.B and Dubey S.D. 2007. Effect of sowing date Moisture Conservation Practices on growth and yield of Indian Mustard (Brassica juncea) varieties. *Indian Journal Of Agronomy* **52**(2) : 151-153>

Banerjee, A., Dutta, J.K., Mondal, N.K., 2010. Impact of different combined doses of fertilizers With plant growth regulators on growth regulators on growth yield of mustard (Brassica campestric cv. B9) under old alluvial soil of Burdwan. *Frontiers Agriculture in China* **4**(3), 341-351.

Bazzaz, M.M., Hossain, A., Forooq, M., Alharby, H., Bamagoos, A., Nurazzaman,M., Khanum, M., Hossain, M.M., Kizilgeci, F., Ozturk, F., Cig, F., Sabagh, A.E., 2020. Phenology, growth and yield are strongly influenced by heat stress in late sown mustard (Brassica spp.) varities. *Pakistan Journal of Botony* **52**(4), 1189-1195.

Bhuiyan, M.S., Mondol, M.R.I., Rahman, M.A., Alam, M.S.,Faisal, A.H.M.A., 2008. Yield and Yield attributed of rapeseed as influenced by date of planting. *International Journal of Sustainable Crop Production* **3**(3), 25-29.

Gawariya, S.C., Chopra, N.K., Chopra, N., Harika, A.S., 2015. Effect of date of sowing and crop Geometry on growth and yield parameters of forage mustard (Var. Chinese Cabbage). *African Journal of Agricultural Research* **10**(33), 3292-3295.

Kithan, L., Malini, B., Sharma, Longchar, A., 2020. Effect of planting dates on the performance of promising pigeon pea genotypes under NEHZ. *International Journal of Economics Plants* **7**(1), 006-008.

Lallu, R.S., Baghel, V.S., Srivastava, S.B.L., 2010. Assesment of mustard genotypes for thermos Tolerance at seed development stage. *Indian Journal of Plant Physiology* **15**(1), 36-43.

Mondal, R.I., Biswas, M., Hydar-Ali, M.K., Akbar, M.A., 1999. Response of rapeseed genotype Dhali to seed rate and seeding date. *Bangladesh Journal of Agriculture Research* **24**(1), 83-90.

M.L.Jat, J.C.Dagar, T.B. Sapkota, Yadvender-Singh, B. Govaerts, S.L. Ridaura, Yadvinder-Singh, B. Govaerts, S.L. Ridaura, Y.S. Sahrawat, R.K.Sharma, J.P. Tetrawal, R.K.Jat, H. Hobbs C. Stirling., 2016, Chapter Three – Climate Change and Agriculture : Adaptation Strategies And Mitigation Opportunities for Food Security in South Asia and Latin America. *Advances in Agronomy*, Volume : **132**, Pages 127 – 235.

Sandip Kumar De, Amit Kumar Sinha and Kalipada Pramanik. 2021. Effect of cultivars and date Date of Transplanting on growth and Productivity of Mustard in Lateritic Soil in West Bengal. *International Journal of Economics Plants* **8**(3):172-175.

Singh, A.K., Yeshpal, R.P., 2011. Performance of mustard hybrids under different sowing dates And spacing. *Pantnagar Journal of Research* **9**(1), 16-19.

Singh, R.K., Singh, C.V., 2017. Studies on response of mustard varieties to different sowing dates Under alluvial soils of Indo-Gangetic plains. *International Journal of Applied and Natural Sciences* **6**(3), 9-14.

Samar Pal Singh, B.S Mahpatra, Biswajit Pramanick, Vimal Raj Yadav., 2021. Effect of irrigation Levels, planting methods and mulching on nutrient uptake, yield quality, water and fertilizer productivity of field mustard (*Brassica rape* L.) under sandy loam soil. *Agriculture Water Management*, **244**.

Singh Samar Pal, Mahapatra B.S, Pande Pooja, Yadav Vimal Raj. 2019. Influence of water Management planting methods and mulching on growth, root dry weight, root density, Yield and yield attributes and water-use in yellow sarson (Brassica rapa). *Indian Journal of Agronomy*. **64**, Issue-4: 511-516.