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The Effects of Different Seed Rates on Yield and Economical Feasibility of Mustard (*Brassica juncea*)

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ABSTRACT

Rapeseed-mustard plant (Brassica *juncea*)" is any one of several plant species in the genera Brassica, *Rhamphospermum* and *Sinapis* in the family Brassicaceae (the mustard family). Mustard seed is used as a spice. Grinding and mixing the seeds with water, vinegar, or other liquids creates the yellow condiment known as prepared mustard. The seeds can also be pressed to make mustard oil, and the edible leaves can be eaten as mustard greens. Many vegetables are cultivated varieties of mustard plants; domestication may have begun 6,000 years ago. Mustard is a popular condiment, commonly it is a popular condiment made from the seeds of the mustard plant. It can be prepared using white/yellow mustard, brown mustard, or black mustard seeds mixed with liquids, salt, and other flavorings to create a paste or sauce. Mustard pairs well with meats, vegetables, and cheeses and is commonly used in sandwiches, hamburgers, and hot dogs. It is also used in dressings, glazes, sauces, and marinades around the world. The word "mustard" has origins in Latin and French, and archaeological evidence suggests mustard cultivation dates back to ancient civilizations like the Indus Valley. Mustard has a long history of culinary use, with the Romans likely being the first to experiment with mustard as a condiment. In France, Dijon became a renowned center for mustard making, and Dijon mustard is still highly regarded today. Mustard has various uses, such as a condiment, an ingredient in sauces and soups, and an emulsifier in dishes like Hollandaise sauce. The flavor and heat of mustard depend on the seed type and preparation method. Mustard offers nutritional benefits such as vitamins, minerals, and omega-3 fatty acids. Mustard plants is used for producing edible oil for human, oil-cake for feeding animals, sauce, spices, medicine and other purposes in Afghanistan.

Mustard has a long history in Afghanistan and is mostly cultivated in the Northern provinces such as Baghlan, Kunduz, Thakkar, Samangan and etc. For the above-mentioned importance of Mustard, we decided to apply a research on seed rates to fine the desirable seed rate of mustard crop for Afghan Mustard growers. Seed rates are one of the important factors, which the suitable seed rates prevent from the economic loss of farmers. This research accomplished in the title of "The effects of different seed rates on yield and growth components of mustard (*Brassica juncea*)" The research was designed in a complete block design (RCBD) with three replications and five treatments. The data were collected from growth parameters such as plant height, number branches plant^{-1}, number of leaves plant^{-1} as well as yield parameters such as number of pods plan^{-1}, number of seeds plant^{-1}, seed yield kg ha^{-1}, dry matter kg ha^{-1} and biological yield kg ha^{-1}. The collected data were analyzed using excel, OPSTAT online testing program, statistical tool for agricultural research (STAR). Based on the statistical analysis the significant differences were observed in all parameters at (P≥0.05. Least significant difference (LSD) was used to compare treatments. A positive correlation was also recognized between growth and yield parameters. Mostly treatment three (15 cm) space between rows performed high influence then the other treatments. We recommend much more research to find the best space between plant to plant and row to row. For the moment the farmers of Afghanistan can use the result of this research on their field for obtaining high yield from Mustard.

Keywords- Mustard, Space, Seed rates, Yield, Growth.

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I. INTRODUCTION

Rapeseed-Mustard has been cultivated in many parts of Eurasia for centuries and is suitable for subtropical and temperate climate cultivars. Mustard is the most important rabi oilseed crops of India and third leading source of vegetables oil in the world. Mustard has been grown for thousands of years as lamp fuel, cooking oil and as forage. During World War II, mustard acreage increased dramatically because it was used as a lubricant for steamships. In course of time, mustard has become a promising oilseed crop in the world (Weber et al., 1995).

In India, rapeseed and mustard are cultivated on an area about 6.70 million hectares with 7.96 million tonnes production and 1188 kg ha^{-1} average productivity (Anonymous, 2014). In Gujarat, rapeseed and mustard are cultivated on an area of 0.28 million hectares with average productivity of 1582 kg ha^{-1} (Anonymous, 2014). In India mustard is grown mainly in rabi season and its productivity is lower than other developed nations generally due to imbalanced fertilization with poor water management. Optimum spacing ensures proper growth of both aerial and under-ground parts of the plant through efficient utilization of solar radiation, nutrients and land as well as air spaces and water (Ward et al., 1985).

The plant density can be adjusted by the use of different seed rates and row spacing. Seed rate thus influences yield and yield contributing characters of mustard (Johnson et al., 2001).

Mustard is a cheap and nutritious food that contains bioactive components such as glucosinolates and their degradation prod interaction effect between inter and intra row spacing found significant and produced highest grain yield in 45 cm x 15 cm spacing (Chaniyara et al., 2002).

One important result from white mustard was that final emergence rates were always high and it was the progress in emergence that varied widely, from less than a week to several weeks. The final heterogeneous aspects of sowings in this study were mainly related to the progression of emergence (Dorsainvil et al., 2005)

This can be improved through effective utilization of diverse germplasms. Several Researchers had tried to improve seed quality, yield and other parameters of Brassica (Kumar, 2017). The rapeseed-mustard contains 40-45% oil and 20-25% protein. About 13.2% of the annual world edible oil supply comes from this crop (FAO, 2007). It is extensively grown traditionally as a pure crop as well as intercrop or mixed crop in marginal and sub-marginal soils in the eastern, northern and north western district of Bangladesh. However, the seed yield of mustard in Bangladesh is about 760 kg ha^{-1}, which is very low in comparison to other developed countries (2400 kg ha^{-1}) (FAO, 2007). There is a great scope of increasing yield of mustard by selecting high yielding varieties and improving management practices. Suitable seed rate and line sowing method are the most important practice for mustard production (Mondal *et al.*, 1999).

The different genotype growth response varies to different environment and their relative ranking usually differ and ultimately decides the selection of genotypes for a particular or different sowing dates for stabilized higher yields (Eberhort and Russel, 1966). The mustard genotypes differ in their yielding ability, this call for a need to generate more information on the response of mustard genotypes to the dates of sowing for greater yields in a given agro-climatic condition.

Considering the congenial environment for the cultivation of mustard, there is further possibility to boost up its productivity up to a considerable level by manipulation of agronomical practices (Patidar *et al., 1996).* Among different cultivation practices, effective weed management is imperative for realizing desired level of productivity as weed infestation alone causes up to 56% yield reduction in Indian mustard (Patel *et al.*, 1997).

In the past, the area under Rapeseed-Mustard globally increased from 6.3 million hectares in 1961 to 34.3 million hectares in 2012 with a mean increment of 0.56 million hectares per annum. Production in the same period increased from 3.68 to 65 previous years. Rapeseed and mustard are generally grown on marginal lands with poor fertility status. Hence, they also suffer from nutrient stress. Sowing time is one of the most important nonmonetary inputs, which influences the productivity of seed and oil to a great extent (Pavlista, 2011).

The highest seed yield (1409 kg ha^{-1}) was obtained for the 35.0 cm row spacing and 200 seeds m^{-2} seeding rate combination without serious lodging problems (Bilgili et al., 2003).

The study envisaged that days to maturity, plant height, branches, pods, seed weight $plant^{-1}$, seed index, seed yield and oil content were affected significantly by row spacing. Among all, 60 cm row spacing proved to be best and is recommended for maximum seed and oil production (Oad et al., 2001).

The roots are also able to increase their uptake rate capacity rapidly in order to compensate shoot N requirement, but only about 50% of the applied N fertilizer is recovered in the harvested seeds (Schjoerring et al., 1995). The plant with high photosynthetic production may be an ideal ideotype for increased N assimilation and thereby with reduced N losses.

The plants with higher sink: source ratio had higher photosynthetic and net assimilatory rates, increased translocation from photo assimilatory to sink organs and increased source and sink activities (Rogers et al., 1995; Mei and Yun, 1999).

Shading can reduce the number of flowers and pods produced by reducing the C assimilates, depending upon the duration and reduce pod size and number of seeds per pod in rap seed (Tayo and Morgan, 1979).

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Different levels of population density did not have any significant effect on the number of branches plant $^{-1}$ (Wankhede Salami, 1970). Seed rates are affected on yield and yield components of rapeseed (Mondal and Islam, 1993).

Relationships between various growth and yield contributing parameters of rapeseed-mustard varieties under different seed priming options, based on the coefficient of determination (R^2), among the parameters, highly strong, positive linear relationships were found between days to maturity and plant height (R^2= 0.9122) (Das et al., 2020).

Seeds grown at higher seeding rates gave the higher number of plants m-^{2} and higher silique surface area, with longest period for seed formation, the highest plants height bearing higher number of primary branches, higher harvest index and high oil percentage. However, seeds grown at low seeding rates, the period from sowing to flowering and flowering period were the longest (Sarkees, 2013).

II. MATERIALS AND METHODS

A field experiment entitled "The effects of different seed rates on yield and economical feasibility of mustard (*Brassica juncea*)**"** was conducted on May 25, 2023 and harvested on August 9, 2023. The seeding of the *Brassica juncea* emerged out within 7-9 days after sowing (DAS). Gap filling was carried out 12 DAS and plant population of each treatment plot was maintained.

A field experiment was carried-out in the two different southern blocks of Agriculture Faculty Farm of Kabul University, Kabul Afghanistan. The summer of Kabul is hot; dry or clear, and winter is very cold; snowy or partly cloudy. Over the course of the year, the temperature typically varies from *24°F* to *93°F* and is rarely below *14°F* or above *99°F*.

In order to determine the physical and chemical properties of the experimental soil research site, the replicated soil samples were collected randomly from the whole field at 0-30 cm soil depth. The samples were mixed to form composite sample, for mechanical and chemical analysis and finally the sample analyzed precisely. The soil texture recognized sandy clay loam.

The crops grown in the experimental field during the last four years are: wheat (2019), fallow, (2020), maize- wheat (2021), fallow (2022) and present investigation (2023).

This research was conducted in the farm of Agriculture Faculty into two different blocks or two different trails field each experimental field was 60 m^2. The experiment was designed in a Randomized Complete Black Design (RCBD) with three replications and five treatments with 15 plots. Each plot contains 4 m^2 (2m x 2m). The seed rates of mustard applied in the form of different as per the experimental treatments. Mustard (*Brassica juncea*) seeds (5, 10, 15, 20 and 25 kg ha^{-1}) were sown and distance between rows was 30 cm. Seeds were sown manually at 3-4 cm depth in line, each plot had 7 rows. Data of yield and growth attributes were recorded at different stages of the crop growth.

The recommended level of N was applied at the time of sowing, and during the podding.

The N was uniformly applied in all the plots at 30 kg N ha^{-1}during the last land preparation in the form of Urea. The P was applied through the DAP as basal dressing i.e. at the time of sowing.

Weeds compete with crops for water, radiation, nutrients and space. Hand weeding was undertaken to conserve the soil moisture. Weeds were managed by hand weeding after emergence. Late-emerging weeds were removed by hoeing to avoid interference with mustard crop. Weeding was done at 30, 50 DAS.

The first irrigation was supplied at 5 DAS after sowing and the 9 additional irrigations were supplied to the fulfillment of crop with 7 days irrigation interval.

Harvesting was done manually from net plot at physiological maturity when the pods were turned yellowish brown. Then net plot area of each treatment was harvested by cutting the plants above the ground. The picking of pods was done at three different stages of maturity. The harvested pods and plants of each individual plots were collected, packed, bundled, tagged, brought to a clean threshing floor and thrashed separately. The crop and pods were sun-dried for seven days by placing them on the open threshing floor. Seeds were separated from the pods and plant bundles with the help of foot treading and by beating with bamboo sticks. Treatment wise grain and straw yield was weighed and recorded and the final grain and straw yield was expressed in kg ha^{-1}.

Ten plants randomly were selected to measure plant height, and these plants were measured from ground level to the tip point of the main stem of the plant at maturity stage in cm.

The numbers of primary branches plant^{-1} were recorded from ten plants that were randomly selected in each plot.

A total of plants were cut from crown at different growth stages (30 DAS, 60 DAS and at harvest time) from each experimental plot for measurement of dry matter. The plants were chopped into pieces and after sun drying, air-dried for 10 days and weighed and recorded by using electronic balance. The above-ground dry matter accumulation was averaged and expressed as gram plant^{-1}.

The 10 pods of each treatment were taken from each plot randomly for measuring the pod length.

Pods were picked up from 10 randomly selected plants and counted.

Pods were collected from all plants plot^{-1}. The seeds plot^{-1} was weighted from each plot of experimental site.

The pods were collected from the randomly selected five plants and counted. Then the number of seeds

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was divided by the number of plants and thus the number of seeds plant^{-1} was calculated.

The seed obtained from net plot area were sun dried carefully and converted the seed yield to kg ha^{-1}. The moisture percentage in the seed was recorded at the time of recording the seed yield. The seed yield was adjusted to 12% moisture content and expressed as kg ha^{-1}.

After threshing of mustard, the biomass was sun dried for several days to reach a constant weight, and thereafter the straw yield was calculated and weighed. The straw yield treatment^{-1} was converted into kg ha^{-1}.

The weight of total harvested product from net plot of each treatment was recorded after sun drying and expressed as biological yield in kg ha^{-1}. The harvest index was computed by dividing economic yield (seed yield of mustard) by the respective biological yield (total product) and was expressed as percentage (%).

$$\text{Harvest index (\%)} = \frac{Economic\ yield\ x\ 100}{Biological\ yield}.$$

The obtained data were analyzed using OPSTAT online testing program. F-test and the coefficient difference values were calculated for the significant exhibited parameters at 5 % level of significance. The data were analyzed using (Statistical Tools for Agricultural Research (STAR) and then indicated by (ANOVA) and the least significance difference (LSD).

The interactions among the treatments were also given wherever interaction effect was significant (Rajasekhar et al., 2020).

III. RESULTS

Growth parameters

The results of field experiment entitled "The effects of different seed rates on yield and economical feasibility of mustard (*Brassica juncea L*) explored the results. The data pertaining to growth, yield attributes and yield recorded during experimentation were statistically analyzed and significance of the results verified. The data have been reported in tables and also depicted graphically, wherever found necessary for better understanding of important trends.

Application of Different seed rates had significant influence on plant height. The tallest plant at t_2 (66.38 cm) and the shortest plant at (t_1) (59.02 cm) exhibited, respectively. Application of different seed rates performed a significant difference among treatments at 5% level. Treatments two performed the largest number of branches per plant and treatment five exhibited the less number of branches per plant. Different rates of seed explored a significant difference among treatments at 5% level. Treatment three showed the largest number of leaves per plant and treatment one exhibited the less number of leaves per plant (Table 1).

Table 1. Evaluation of seed rates effects on growth parameters of mustard (*Brassica juncea L*).

Treatment	Plant height (cm)	Number of branch plant^{-1}	Number of leaves plant^{-1}
5 kg ha^{-1}	62.47^{bc}	3.16^{bc}	11.97b
10 kg ha^{-1}	66.38^{ab}	3.65^{b}	13.87ab
15 kg ha^{-1}	66.03^{a}	4.39 ^{a}	15.32a
20 kg ha^{-1}	63.73^{abc}	3.34^{bc}	12.53b
25 kg ha^{-1}	59.02^{c}	3.05^{c}	11.92b
CV	6.58	13.46	15.43
LSD (0.05)	5.14	0.57	2.47
F-Value	*	*	*

CV: Coefficient of variation, LSD: Least significant difference, *: Significant level at (P<0.05).

Yield Parameters

Obtaining of high yield is the objective of researchers, to achieve this objective different factor that are affected on growth and yield components take under investigation by researchers. In this study we decided to start research on different seed rates and their effects on growth and yield parameters of mustard (*Brassica juncea L*).

Based on statistical analysis there is a significant difference in pods per plant among treatments using different levels of seed rates at 5% levels. The largest number of pods per plant observed in treatments three (65.95) and the less number of pods per plant exhibited in treatment one (61.05). According to the results, there is a significant difference among treatments in number of seeds per plant at 5% level. Treatment three exhibited the largest number of seeds per plant and treatment five performed the less number of seeds per plant. Different seed rates of mustard had significant influence on seed yield plant^{-1} at (P<0.05). The highest yield obtained from treatment three and the lowest yield obtained from treatment one. The result showed that there is a significant difference among treatments in dry matter at (P<0.05). The highest dry matter obtained from treatment three and the lowest dry matter obtained from treatment five. Yield is an important parameter among all parameters; based on the result of this research different seed rates performed a significant difference among treatments at (P<0.05). The highest yield obtained from treatment three and treatment one exhibited the lowest yield. The results indicated that there was a significant difference at all parameters at (P<0.05) (Table 2 & Fig. 1).

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Table 2. Assessment of yield components response to different seed rates of mustard (*Brassica juncea L*).

Treatments	Number of pods plant^{-1}	Number of seeds plant^{-1}	Seed yield plant^{-1} (g)	Dry matter (kg ha^{-1})	Yield (kg ha-^{1})
5 kg ha^{-1}	61.05^{b}	1235.98^{bc}	10.65^{b}	1846.33^{b}	1686.67^{c}
10 kg ha^{-1}	63.75^{ab}	1312.67^{ab}	13.18^{ab}	2159.29^{ab}	1875.00b^{c}
15 kg ha^{-1}	65.95^{a}	1412.50^{a}	14.68^{a}	2533.27^{a}	2140.00^{a}
20 kg ha^{-1}	63.83^{ab}	1242.77^{bc}	12.15^{ab}	2162.92^{ab}	1936.75^{b}
25 kg ha^{-1}	62.00^{b}	1156.00^{c}	11.93^{b}	1839.08^{b}	1823.33b^{c}
CV	4.12	9.92	16.88	1845	8.38
LSD (0.05)	3.19	154.41	2.58	476.17	194.02
F-Value	*	*	*	*	*

CV: Coefficient of variation, LSD: Least significant difference, *: Significant level at (P<0.05).

Application of different seed rates had significant influence on biological yield of mustard at (P<0.05) (Fig. 1). Treatment two produced the highest biological yield than the others and treatment five exhibited the lowest yield among treatments (Fig. 1)

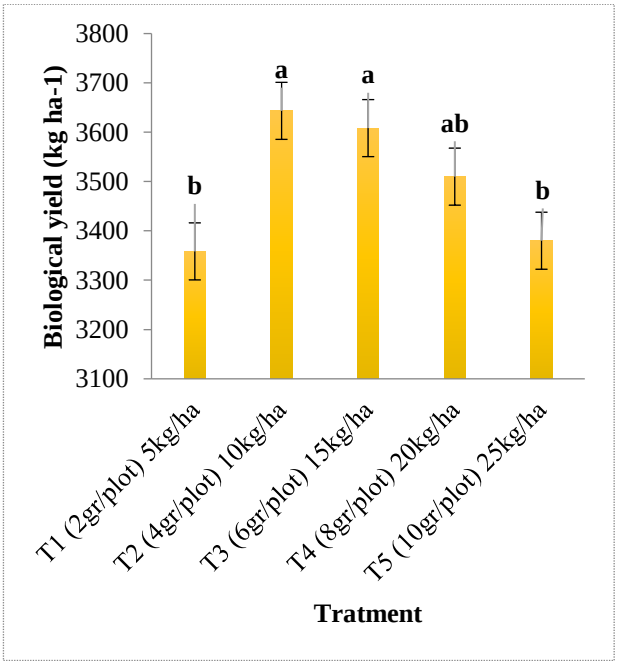

Fig 1. Effects of different seed rates on biological yield (kg ha^{-1})

Statistical analysis using statistical tools for agricultural research and Pearson's product-moment correlation, Prob > |r| showed that there is a positive correlation between growth and yield parameters at (P<0.05) level (Table 3 & Fig. 2). Therefore, we can conclude that desirable growth parameters are yielded the best yield parameters and finally are resulted high yield.

Table 3. Pearson's product-moment correlation, Prob > |r|

		GP	YP
GP	coef	1.0000	0.8783
YP	coef	0.8783	1.0000
	n	5	5
	P-value	0.05	

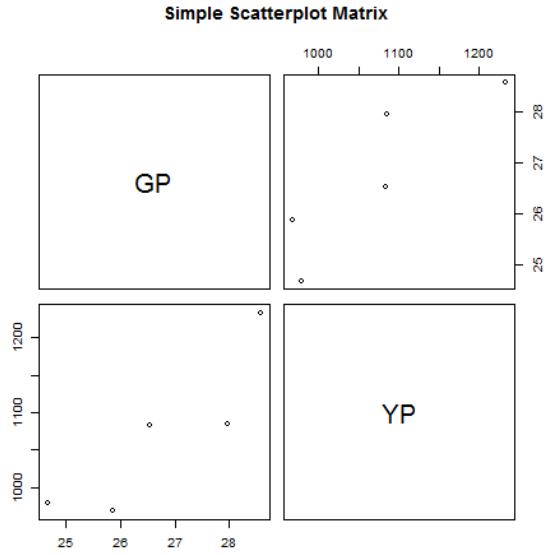

Fig 2. Simple scatterplot matrix between growth and yield parameters of mustard resulted from correlation analysis.

IV. CONCLUSION

Mustard *(Brassica juncea)* is also significantly higher yielder than the other brassica family. The importance of mustard hardly needs to be mentioned. The mustard grain is the good source of human vegetable oil and protein, an essential source of protein for about 700 million people. The anticancer and antioxidant mechanisms of mustard extract, mustard seeds, pods and leaves are consumed in fresh form as green vegetables. Mustard is also a nutritious fodder for livestock. Application of different seed rates to achieve desired yield potential of the crop. We have taken this opportunity to serve the above-mentioned purposes of fine-tuning. As a result, a field experiment entitled "effects of different seed rates on yield and economic feasibility of mustard (*Brassica juncea*)." was carried out in 2023 in the research farm of Kabul University. The experiment was laid out in RCBD design, consisting of total 5 treatments. We can conclude that desirable seed rates can contribute farmers to obtain high yield and to reduce the cost of production.

As a conclusion, we found that 15 kg ha^{-1} seed is a desirable amount of seed rate for mustard. We applied different methods of statistical analysis to find the significant difference among different seed rates.

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Based on the results, treatment three was performed better growth and yield than the others. There was a positive correlation between growth and yield parameters and significant difference among treatments at (P>0.05) level. We recommend that The Ministry of Agriculture Irrigation and Livestock to invest in the researches that focuses on oil seeds. This research has the potential to surpass the boundaries of crop productivity and economic growth, addressing food security concerns, alleviating poverty, and promoting sustainable agricultural practices. This study can pave the way for more investigation on oil seeds in Afghanistan.

REFERENCES

[1] Anonymous. (2014). Agricultural statistics at a glance, Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Government of India.

[2] Bilgili, U., Sincik, M., Uzun, AM. and Acikgoz, E. 2003. The influence of row spacing and seeding rat on seed yield and yield components of forage turnip (Brassica rapa L.). J. Agron. and Crop Sci. 189(4):250.

[3] Chaniyara, N.J., Solanki, R.M. and Bhalu, V.B. 2002. Effect of inter and intra row spacing on yield of mustard. Agric. Sci. Dig. 22(1):18-50.

[4] Das, R., Biswas, S., Biswas, U. and Dutta, A. (2020). Growth, Yield, Seed and Seedling Quality Parameters of Rapeseed-mustard Varieties under Different Seed Priming Options, International Journal of Environment and Climate Change. explored that there existed linear. 10(3): 1-14.

[5] Eberhort, S.A. and Russel, W.A. (1966). Stability parameters for comparing varieties. Crop Sci6:36-40.

[6] Dorsainvil, F., EricJustes, C. D. and Carrera, A. (2005). Characterisation and modelling of white mustard *(Sinapis alba L.)* emergence under several sowing conditions, European Journal of Agronomy,September, 146-158.

[7] FAO/WFP. (2005). Crop and food supply assessment mission to Afghanistan. p.13.

[8] FAO (Food and agricultural Organization). (2007). FAO Production year Book. Rome, Italy, Vol. 61.p.64.

[9] Johnson, L.B., Patrick, M.C., Ericksmoen, E.D., Bryan, E.H. and Nild, R. (2001). New Canola production Practices Challenge Research to Provide Defined Techniques to producers Dickinson Research Extension Center. Annual Report.

[10] Kumar Arvind. (2017). Proceeding of 3rd national brassica conference held at IARI New Delhi on dated. 16- 18:7.

[11] Mondal, M.R.I. and Islam, M.A. (1999). Effect of seed rate and date of sowing on yield and yield components of rapeseed. Bangladesh J Agric. Sci. 20(1):29-33.

[12] Oad, F.C., Solangi, B.K., Samo, M.A., Lakho, A.A. and Oad, N.L. (2001). Growth, yield and relationship of rapeseed (B. napus L.) under different row spacing. Int. J. Agril. Biol. 3(4):475-476.

[13] Patel, R. M., Patel, A. G. and Tikka, S. B. S. (2004). Response of summer mungbean to date of sowing and levels of fertilizers. Gujarat Agricultural University Research Journal 29(1-2): 42-44.

[14] Patidar, M., Singh B. and Chauhan, K. N. K. (1996). Sulphur increases mustard yield in western Rajasthan. *Indian Fmg.* 45: 3-4.

[15] Pavlista, A.D., Isbell, T.A., Baltensperger, D.D. and Hergert, G.W. (2011). Planting date and development of spring-seeded irrigated canola, brown mustard and camelina. Industrial Crops and Products. 33:451–456.

[16] Rogers, A., Bryant, J.B., Raines, C.A., Long, S.P., Blum, H. and Frehner, M. (1995). Acclimation of photosynthesis to rising CO_2 concentration in the field. Is *it* determined by source/sink balance? In: Photosynthesis: from light to biosphere (Ed. P. Mathis). Vol. V. Proceedings of the X"* International photosynthesis congress, Montpellier, France, 20-25 Aug. 1995, pp. 1001-1004.

[17] Rajasekhar, D., Ranjithkumar, G. and Manjunath, P. (2020). Genotypic, phenotypic correlation and path analysis using OP Stat. Aguculture and food: e-newsletter. www.agrifoodmagazine.co.in.

[18] Sarkess, N.A. (2013). Response of Growth, Yield and Oil of Rapeseed to Sowing Method and Seeding Rate. IOSR-JAVS (3) I: 1-6.

[19] Schjoerring, J.K., Bock, J.G.H., Gammelvind, L., Jensen, C.R. and Mogensen, V.O. (1995). Nitrogen incorporation and remobilization in different shoot components of field-grown winter oilseed rape *{Brassica napus* L.) as affected by rate of nitrogen application and irrigation. Plant and Soil 177: 255-264.

[20] Tayo, T.O. and Morgan, D.G. (1979). Factors influencing flower and pod development in oil seed rape *(Brassica napus* L.). J. Agric. Sci. 92: 363-373.

[21] Ward, J.T., Basford, W.D. and Hawkins, J.H. (1985). Oilseedrape Farming Press Suffolk.

[22] Weber, J. A., Myers, L.R. and Minor, C.H. (1991). Canola: A promising oilseed. Canola, Inc., 8910 Purdue Road, Suite 150, Indic napolies. IN 46268.