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Response of different varieties, planting density and sowing window on field crops: A review

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Abstract
Sowing dates, varieties, and planting density are the most important factors for enhancing growth, maintaining the quality of the seed, improving soil health and increasing the yield of field crops. The length of the growing season can be directly impacted by different planting dates which affect different field crop varieties from the vegetative stage to till maturity stage. To reduce the effects of fast climate change, it is necessary to evaluate the situation and identify strategies that are suitable for different field crops. The most important elements of a cropping system are timely sowing and effective variety selection. Early sowing crops can receive sufficient solar radiation which leads to the tallest plants with more leaf area and high dry matter content due to the extended growing period grains will have more time to mature resulting in high grain yield, biological yield, harvest index, B:C ratio, gross return and net return. Sowing crops at the appropriate time using recommended hybrid varieties and planting them at low or high-density patterns required by the crops through improved agronomic techniques are the main reasons for higher productivity. Evaluating different maize varieties under different sowing dates provides a novel strategy for improving their productivity. The goal of the current study was to ascertain how different varieties, their planting densities, and sowing dates affect the growth, yield, quality, and economics of various field crops.

Keywords: Economic, growth, planting densities, quality, sowing date, varieties, yield etc.

Introduction
Field crops are grown on a large scale for consumption purposes. They are usually annual with a life cycle of 3 to 5 months. Crop plants can be used for phytoremediation because they have high biomass production and can easily adapt to the changing environment. Thus, includes crops like maize, sorghum, soybean, wheat, barley, cotton, potatoes, sugar beet, sugarcane, hay, pasture and many others. The sowing date clearly influences the soil temperature and soil water availability experienced by germinating seeds and therefore manipulating the sowing date could be an efficient practice to help the crop to better escape from biotic or abiotic stresses. However, the specific response to the sowing date depends on the location and farming system. Planting density is a simple yet critical variable that links individuals to crops. Plant density is the number of individuals per unit of ground area. In many circumstances, the identification of the individuals obviously has a significant role in increasing the biomass of the plant. Increasing plant density is the most important way to increase yield per hectare yield potential in maize in the past decades Duvick (2005) [17]. Sowing dates significantly impact the yield of agronomic crops to produce the highest yield potential Olumi *et al*., (2022) [29] and an important element to improve the effectiveness of resource usage is the right planting time and the accumulation of necessary thermal time for proper growth and development of agronomic crops is made possible by adequate planting date in a particular ecological environment Abbas *et al*., (2019) [4]. Jarecki, W., &Bobrecka-Jamro, D. (2021) [23] evaluated that planting time is essential in soybean production because it impacts the establishment of vegetative, generative organs and ultimate biomass. Appropriate planting time of diverse field crops leads to improved economic production since it allows varieties to show their maximum development potential Singh *et al*., (2021) [42]. Lower yield can be obtained due to many reasons maybe because of the cultivation of crops using outdated varieties and sowing at inappropriate sowing dates Fazily, T. (2021) [19]. When field crops are sown at proper sowing dates, varieties show their maximum growth potential, which increases economic yield without any additional costs Ali *et al*., (2010) [1] significantly under changing climatic conditions in the present and the future Abbas *et al*., (2019) [4].

Delay in sowing prevents the plant from receiving the right circumstances for its growth, which leads to low productivity or complete failure of germination Ahmed *et al*., (2011) [3] similar results were found by Buriro *et al*., (2015) [11]. High temperatures and strong winds during the grain-filling phase under late-sown conditions caused the grains to shrivel, which eventually decreased the crop's grain output Fazily, T. A. M. I. M., & Habibi, A. I. N. U. L. L. A. H.*et al*., (2019) [18]. Plant density is defined as the number of plants present per square meter and the total area available to each plant. One of the most crucial elements affecting crop growth, development, and yield is plant density Zand, N., & Shakiba, M. R. (2013) [51]. An increase in plant density shows the relative growth rate, net assimilation rate, plant height, total dry weight per plant and leaf area per plant will gradually increase when crops are sown at lower densities. This will happen less frequently. There was no distinct difference in grain yield between plant density and sowing date. Field crop growth and yield responses to significant changes in plant density and sowing dates by using different hybrid varieties have been considered and those changes will affect seed quality, yield potential and economic return Soleymani, A., & Shahrajabian, M. H. *et al*., (2012) [40]. When sowing is carried out at a certain interval it may have an impact on growth, development, yield and Ahmad *et al*., (2021) [7] maturity phases resulting in increased yield production because the interplay between sowing date and plant density greatly affects grain yield Tokatlidis *et al*., (2010) [45]. To achieve increased output, precise planting times should be used because cultivar-specific planting timings differ greatly from one another Ahmad *et al*., (2021) [7]. According to Tokatlidis *et al*., (2010) [45] to obtain maximum yield, one should always follow optimum plant density patterns and hybrid variety field crops to be selected for successful cultivation and development of new cultivars that will supply food for future generations. Due to the interaction of crop-weeds and their higher levels of competition for water, nutrition, sunlight, carbon dioxide and fertilizers in some individual plants yield components tend to significantly decrease with increased plant density. This results in a decrease in yield and seed yield per hectare with increased plant density. Saini *et al*., (2018) [38] stated that the duration of the growing season is directly influenced by the date of planting; cultivars belonging to various maturity groups will be impacted accordingly. Plant density has a significant impact on biomass, crop production, and economic position. Plants utilize available resources efficiently at the ideal plant density Soleymani, A., & Shahrajabian, M. H. (2012) [40] but at high plant densities, there will be huge competition among the plants, so they compete with one another for nutrients and light which will also foster the growth of pests and diseases Tuong *et al*., (2019) [53]. The appropriate stand establishment of the growing crop is determined by balancing the plant-to-plant competition, which has a direct impact on the yield, so the timing of sowing and the planting density is very important Baloch *et al*., (2010) [9]. The length of the growing season can be directly impacted by planting dates and different hybrid varieties of some crops will be affected as they mature. For these reasons, the goal of the current study was to assess how different varieties, planting densities, and field crops' growth, yield, quality and economics of various field crops were affected by these factors.

Scope and importance of planting densities, varieties and sowing dates

Making the best use of vertical and horizontal space per unit area planting densities is one of the widely practiced method. By practicing high plant density, the land can be efficiently used by reduction of land wastage. In low plant density individual plant can grow vigorously and also utilizes all the available soil nutrients and other resources sufficiently for crop growth and development resulting in ultimate yield production.

The selection of hybrid varieties is also one of the major factor that can significantly impact the growth, yield and quality parameters of certain crops. The selection of cultivars should be based on their adaptability to a particular season, land location and soil type, before sowing seed check the germination and purity percentage of a particular seed along with their capacity to tolerate climatic conditions like high or low temperatures. Sowing the crops too early or too late can result in reduced growth parameters that lead to low yield and poor-quality parameters. By following appropriate planting time plants can use optimum resources like sunlight, rainfall, etc. and they can adjust to the available high or low-temperature conditions according to crop demand. Majority of farmers sow crops in the off-season or early season or at late season in a particular land area without knowing about the correct planting dates for particular crop varieties. The sowing dates are the no-cost input method that must be taken into consideration to obtain maximum yield and economic returns.

Effect of Different Varieties, Planting density, and sowing dates on Growth and Yield of field crop

Low yield can be attributed to a variety of factors, including planting dates, selection of varieties, seeding rates, planting geometry and soil type. The sowing time is the component that has the greatest impact on yield among all these agronomic methods Tanveer *et al*., (2009) [44]. Wheat that is sown at the right time will have the best chance of developing, accumulating more biomass, and producing a better grain and biological yield Habibi, A., & Fazily, T. (2020) [21]. Early planting produces higher yields than late planting because of the extended growing season Singh *et al*., (2021) [42] similar results were found by Tanveer *et al*., (2009) [44] and Baloch *et al*., (2010) [9] strong development, quick and uniform seedling emergence, and superior combination of leaf size and tiller number. The timing of sowing had a significant impact on grain output as progressive vegetative development is related to several yield components. A delay in sowing caused a substantial reduction in crop developmental characteristics and yield attributes Mumtaz *et al*., (2015) [28]. Early sowing results in weak plants with under-developed root systems, which cause uneven germination, frequent embryo mortality, and degradation of endosperm due to bacterial or fungal activity. While late planting has an impact on germination, growth, and grain development it also results in poor tillering because of winter damage in cold temperatures Habibi, A., & Fazily, T. (2020) [21]. When plant density increased from 50 to 1600 plants per square meter, the number of leaves decreased from 10.2 to 8 and also a reduction in grain yield was caused by early sowing Soleymani, A., & Shahrajabian, M. H. (2012) [40]. Delay in sowing results in lower grain and stover yield but *kharif* sorghum sown during the onset of monsoon season recorded higher stover yield and grain yield because at the early sowing

period, there are favorable climatic factors and sufficient time at seed germination and seed filling stage that results in higher seed yield Saini *et al*., (2018) [38]. Delay in planting lowered yield due to a decrease in features that contribute to yield, such as the number of tillers, number of grains per spike, and grain yield Tahir *et al*., (2009) [43]. The highest grain yield was obtained on the early sowing date while delay in sowing reduced seed yield, vegetative period, day to maturity, grain filling period, spike number, grain weight Shirinzadeh *et al*., (2017) [36]. According to Karhale *et al*., (2014) [25] among the four sorghum varieties PSH-71, MSH-51, BGL-296, and PVK-801, PSH-71 variety recorded the highest plant height, leaf area, and accumulation of dry matter, and it produced the highest yield of 1451.31 kg per hectare it is superior variety in comparison to the other varieties. Tahir *et al*., (2009) [43] stated that due to the shortened growth period, plant height decreased with late sowing. Early planted crops would have benefited from improved climatic circumstances, particularly in terms of solar radiation, which led to the tallest plants and grains having more time to mature so, the early sowing produced superior grain development. Plant density influences productivity, according to research by Tokatlidis *et al*., (2010) [45] on maize crops. Therefore, hybrid varieties must be more carefully selected to determine ideal plant density. The best crop stand, which affects the yield and returns, is mostly determined by the planting date and the various types Praveen *et al*., (2018) [31]. According to Inamullah *et al*., (2007) [22] late-sown wheat crops recorded fewer Growing Degree Days (GDD) because of this grain yield of the crop was negatively impacted, whereas early sowing resulted in higher grain yield by early crop germination in the case of barley, which raises the likelihood of critical consequences related to grain yield Soleymani, A., & Shahrajabian, M. H. (2012) [40]. According to Sher *et al*., (2017) [37] plant density has a substantial impact on maize output. The choice of the hybrid type is more efficient and results in a high yield when determining the right plant density. Higher plant densities can lead to reductions in the length, weight, and area of the maize stalk as well as the number of kernels per row, weight per thousand, and ear weight. Zander *et al*., (2021) [52] reported that in early-season plant populations were only significantly impacted by the planting date. In 2016, planting sorghum in April resulted in the largest early-season plant numbers. According to Amerjeet *et al*., (2020) [5] barley sown earlier in the last week of October and at the first week of November performed better in terms of yield attributes, such as effective tillers-2, the number of grains spike^{-1}, and 1000-grain weight compared to later sowings. According to Chandini *et al*., (2020) [15] an ideal planting period is essential to effectively complete all growth phases for the optimal growth and development of rice. Variety NDR 97 outperformed other kinds when planted on August 5th because of delayed planting. Also, the yield of rice gradually declines if planting is postponed past the first week of August. Tiwari *et al*., (2018) [46] stated that sowing time directly affects how quickly rice seedlings take root. Early sowing is ideal for essential qualities such as maximal tillering, panicle initiation, panicle length, number of panicles per meter square, and grain yield Khalifa, (2009) [24]. A delay in planting from 15th June to 15th July lowered the leaf area index. Osmani *et al*., (2020) [30] reported that when four local spring wheat varieties Zardana-Baghlan, Sorkha-Andarab, Safida-Kunduz and Safida-Andarabwere used in two consecutive spring seasons in 2017 and 2018 and they found that Safida-Andarab produced shorter plants throughout both spring seasons but had noticeably more tillers, grains per spike, spike length, test weight (40.33 and 41.33 g), and grain yield of (4.17 and 4.43 tonnes per hectare), being on par with a variety of Safida-Kunduz. Ahmad *et al*., (2021) [7] reported that when the crop was exposed to the ideal temperature and moisture conditions, staller plants are produced at the early growing season. Various cultivars and sowing dates significantly influenced plant height, pod length, and pods/plant. The cultivar NM-2006 generated higher plants than other cultivars due to its strong development. The earlier-planted crop had more time for growth and development and produced more assimilates, which led to the creation of longer pods with more grains. In contrast to other SD, the crop seeded on April 25th had the highest biological yield, which may have been caused by the highest emergence count and longer pods with more seeds. Sarhan *et al*., (2012) [35] conducted a research experiment to investigate the effect of planting density (46000, 35000 and 28000 plants/fed) on the productivity of sugar beet in the 2007/2008 and 2008/2009 seasons. Plants sown in low density in both seasons recorded the greatest values for all yield components, on the other hand, seeding at high plant density 46000 plants/fed produced the smallest values. Sugar beetroot grows vegetatively and more quickly in low-density areas than in high-density areas, which resulted in improvements in yield qualities. According to Tuong *et al*., (2019) [53] corn yields are closely related to yield components such as cob length, cob diameter, number of grain rows per cob, number of gains per row, and 1000-grain weight. These elements have a link even though they were developed at various points in time, followed different rules, and were impacted by various circumstances. If you want to increase corn output, all these elements are taken into consideration. According to Bachhao *et al*., (2018) [12] sowing wheat variety Tapowan in the first week of December had the highest biological yield, grain yield and straw yield than it was to the other sowing dates, but the harvest index reached a major peak when sown in the first week of January.

2. Effect of Different Varieties, Planting Density, and sowing dates on Quality of Field Crops:

According to Yan *et al*., (2008) [48], the ideal planting date results in the best protein content in wheat crop. Sowing dates had no impact on the quality of the seed but at the accelerated aging test, it showed seed dormancy indication Samarah, N. H., & Al-Issa, T. A. (2006) [33]. In the sorghum crop Rabeh variety noticed low protein content (9.58%) while Babel has high protein content (12.21%) crop sown on the second sowing date 1st April resulted in a higher percentage of protein in grain compared to the first sowing on 15th March and third sowing on 15th April. The difference in grain's protein content is noticed because of the grain's easier absorption of nutrients like nitrogen, which aided in the grain's transition from leaves to grains Ajaj *et al*., (2021) [6]. Early sowing of maize recorded the highest protein content, starch and oil content all these gradually decreased in the case of late sowing. Pioneer 1543 variety sown on October 25th had maximum quality parameters while the minimum is observed in the Monsanto DK-6142 variety which is sown on 25th November Buriro *et al*., (2015) [11]. Late sowing of the wheat crop on 5th January obtained higher protein it could be because of the rise in temperature at the crop growth stage that leads to a reduction in leaf area which in turn reduced

absorption of solar radiation and ultimately increased the crop's absorption of nitrogen due to the inverse relationship between carbohydrates and the rate at which it accumulates nitrogen Yusuf *et al*., (2019) [50]. Sowing Tapowan wheat variety at 1st week of December obtained maximum protein content of 11.65% and a protein yield of 4.92 g ha^{-1} Bachhao *et al*., (2018) [12]. Delay in sowing resulted in higher protein and starch content while early sowing obtained high ash and oil content of maize seed Koca, Y. O., & Canavar, O. (2014) [26]. According to Ganvit *et al*., (2019) [20] linseed crop sown in 1st week of November obtained higher oil content (37.53%) and higher oil yield (476 kg per hectare) due to the development of the higher seed. Crop sown at the appropriate period under suitable climatic conditions reported better growth rates and seed yields for higher oil productivity. Yang *et al*., (2014) [49] in his study demonstrated that in cotton crops fewer plants wouldn't yield enough bolls per unit ground surface, and too many plants wouldn't necessarily result in more bolls per unit ground area either, shedding or rotting of cotton bolls may occur due to higher plant density. Lower plant density (less than 2 plants per meter square) was one of the reasons for yield reduction. Higher plant densities decreased the lint yield of irrigated cotton and did not affect the yield of rain-fed cotton. Sharif *et al*., (2020) [41] stated that different varieties have different boll retention percentages, the maximum is obtained in early sown at 50.4%while in late sowing retention percentage was reduced to 44.3%. The key factors influencing fiber quality are length, strength, and micronaire rating. The quality of cotton fiber is good in the FH-152 variety. Qamar *et al*., (2016) [32] reported that the sowing date is the most important component which has an impact on growth and cultivar yield, including fiber quality. Early sowing of the cotton crop on April 15th resulted from the larger number of bolls per plant with high staple length and Oil content for Bt. CRIS-508 variety but micronaire obtained higher in late sowing on 15th May in Bt. CRIS-342variety.The genotype and environmental factors present during the growth stage of the wheat crop have a significant impact on the protein content. Mung bean crop NM-2006 sown early on 25th April recorded maximum biological yield, seed yield and harvest index due to higher seed emergence, lengthy pods with additional seeds and high seed weight while the minimum was observed in Azri-mung 2006 Ahmad *et al*., (2021) [7]. Planting density 148148 (45x15 cm^2) recorded the highest ginning37.30%, seed index 5.21g, lint index 3.11gand halo length 22.74mm. In the case of varieties, PA 528 is the cotton desi variety which shows a significant impact by improving quality parameters except for halo length Kumar *et al*., (2017) [27]. Sarhan *et al*., (2012) [35] reported that quality parameters like TSS%, sucrose%, and perceived purity% were significantly impacted by the sugar beetroot plant density in the 2007/2008 and 2008/2009 seasons. Sowing of sugar beet at a low density of 28000 plants/fed resulted in the greatest percentages of TSS. The greatest averages were achieved for sucrose and apparent purity percentages owing to high density (46,000 plants/fed), followed by middle density (35,000 plants/fed), and finally low density (28,000 plants/fed). Early sowing of the wheat crop on November 15 obtained higher protein content (13.965) compared to late sowing on November 30th (12.968) and December 15th (11.970) Shahzad *et al*., (2007) [34]. An increase in planting densities(70 and 90 seeds per meter square) increased protein content in ES Mentor 00 variety but in the case of lower density (50 seeds per meter square) higher oil content is obtained in Viola 000 variety Sobko *et al*., (2019) [39]. Early planting of peanut recorded higher oil content because of the high-temperature condition but protein percentage increased with late sowing which might be attributed to a lack of seed maturity, which would lead to a late seed-filling period Bakal *et al*., (2022) [14]. According to Umburanas *et al*., (2018) [47], late-sown soybean crop decreased the production of fat and protein as well as the fat content of the seeds. Compared to early sown seed protein content increased dramatically for late sowing soybean crop but early sown Aldana variety seeds contain higher phosphorous and potassium percentage while Merlin recorded higher fat content and Aldana resulted with low protein and fat yield Jarecki, W., & Bobrecka-Jamro, D. (2021) [23].

3. Effect of Different Varieties, Planting density, and sowing dates on Economics of Field Crops:

Linseed crop sown in 1st week of November had the highest net returns of 73,252 per hectare with B: C ratio of 4.47 compared to other sowing dates could be because the appropriate weather conditions that resulted in the tallest plants with good physiological features and enough time for vegetative and reproductive stages to produce higher productivity Ganvit *et al*., (2019) [20]. Rice crop sown on June 20th obtained maximum yield with the highest net revenue of Rs. 56928.67, gross return Rs. 137736 and benefit-cost ratio (1.71) similarly when sowing was done on 10th June and 31st May net return of Rs. 33286.72 and 16438.78 was obtained while delay in sowing 10th and 20th July reduced the yield gradually with lowest: C ratio, net return and gross return Bashir *et al*., (2010) [10]. Desi cotton varieties grown at a planting density of 148148(45 X15 cm^2) obtained the highest gross return (Rs. 87586per hectare), net return (Rs. 50031per hectare), B: C ratio (2.33) and with the cost of cultivation of (Rs. 37555 per hectare) compared to other planting densities 98765 (45 X 22.5 cm^2) 74074 (45 X 30 cm^2). The desi cotton variety PA 528 recorded a high cost of cultivation of Rs. 37393 per hectare, a gross return of Rs. 88017, a net return of Rs. 50623 and a B: C ratio 2.34compared to PA 08, PA 255 varieties Kumar *et al*., (2017) [27]. Early sowing of wheatvarietyPBW-343 on 20th November obtained higher productivity and economic returns than late sowing on 30th November and 10th December with NW-1012 and Malviya 234 varieties Chauhan *et al*., (2020) [16]. Similar results were observed by Yusuf *et al*., (2019) who reported that early sown wheat crop on 3rd July resulted in higher economic returns HI 1544 variety performed best among other varieties. Similarly, Alam *et al*., (2022) [8] found that early sowing of wheat crop recorded higher economic returns that resulted from timely seeding and improved genetic characteristics of the variety's grain production. According to Bachhao *et al*., (2018) [12] sowing wheat crop at the first week of December obtained the highest gross return, net return and B: C ratio while the cost of cultivation was maximum when sown at 3rd week of November. Tiwari *et al*., (2018) [46] stated that early sowing of upland rice on 3rd July recorded a higher yield that resulted in higher net income while late sowing reduced net return. Crop productivity and gross income are both factors that affect net income.PS-3 variety gained the highest net return of Rs. 49778 per hectare than other varieties. Different economic returns were obtained due to differences in varieties. Biswas *et al*., (2022) [13] reported that the Pioneer-30R77 maize variety is superior to Kaveri 50 and obtained high economic

returns. In case of planting density 50×20 cm^2 recorded higher economic returns than 60×20cm^2. The variations in yield between the plant densities may be the cause of the economic difference.

Advantages of planting densities, sowing dates and varieties:

1. Plant density modifies growth and developmental processes, shows impact on carbohydrate production and alters plant architecture.
2. The sowing time is a non-cash input and one of the best agronomic methods, about which information must be discovered to get the best yield.
3. An extended growing phase for the crops at early planting promotes greater light harvesting and higher assimilate production, which results in better growth attributes.
4. Yield and all the yield-related factors of various crops were significantly influenced by the planting dates.
5. For hybrid varieties mid-early sowings might be advised since plants have longer growth periods, their growth and development correspond with favourable environmental circumstances, create vegetative development and reproductive parts, and absorb enough amount of nutrients.
6. Sowing date is probably the most important reason for variation due to the great differences in weather at sowing time between seasons and within the range of climates.

Disadvantages of planting densities, sowing dates and varieties

1. The usage of large populations intensifies competition amongst plants for nutrients, light, and water.
2. High temperature at very early sowing has detrimental effects like inhibiting pollination, increasing respiration and transpiration rates, and in this way, limiting dry matter accumulation, which can cause loss the grain yield.
3. Delay in sowing results in complete failure of seedling's germination at the initial stage. This occurs if the plant doesn't get the proper conditions for its growth which leads to lower productivity it is mainly due to unfavorable environmental effects encountered during the reproductive phase and due to the low net assimilation rate, raising the danger of exposure to deadly cold temperatures before grain maturity.
4. Planting too early or too late can result in insect pest infestation, disease occurrence, heat stress, moisture stress, and severely damages crop at the growth stage and at the time of pollination.
5. Higher planting densities produce more plant populations in a unit area resulting in a higher intra-crop competition that leads to more competition among plants for all the available resources thereby affecting the yield and production cost.
6. Lower planting densities had low plant populations produce fewer number plants is one the reason that eventually decreases the yield in a unit area.
7. Selection of varieties is also one of the main components for enhancing growth, maintaining the quality parameters, improving soil health, and increasing the yield of field crops.

Conclusion

From the various studies, it is concluded that early planting of crops has a positive impact on grain yield and the economic status of the crop due to favorable climatic conditions and long duration period which results in the tallest plants with good physiological characteristics and enough time for grains to mature. Late planting negatively affects crop growth, seed filling stage, and all yield parameters due to their shorter duration. Sowing crops in the early season can results in poor development of crops due to climatic fluctuations like high temperature, heavy rainfall, etc., late sown crops may suffer from fewer sunshine hours, less rainfall, chilling injury or low temperature or have deficient moisture conditions at the time of germination can result in less plant population. Plant density is one of the factors that impact the capacity of the crop to utilize available resources efficiently. Higher planting density produces more plant population in a unit area resulting in a higher intra-crop competition that leads to more competition among plants for sunlight, water, nutrients, space, etc., thereby affecting the yield and production cost. Similarly, lower planting density produces a low plant population which in turn declines crop production. Therefore, the selection of improved varieties with high-yielding stability boost crop production and sowing dates and planting densities are equally crucial to variety selection for soil and seed quality maintenance, to achieve higher economic returns.

Reference

1. Ali MA, Ali M, Sattar M, Ali L. Sowing date effect on yield of different wheat varieties. J Agric. Res. 2010;48(2):157-162.
2. Ali S, Mohamad HS, Lila N. Determination of the suitable planting date and plant density for different cultivars of barley (*Hordeum vulgare* L.) in Fars. African Journal of Plant Science. 2011;5(4):284-286.
3. Ahmed A, Munsif F, Arif M, Ullah I, Nuaman M. Yield and yield components of maize as affected by sowing dates and sowing methods. FUUAST Journal of Biology. 2011;1:75-80.
4. Abbas G, Younis H, Naz S, Fatima Z, Hussain S, Ahmed M, *et al*. Effect of planting dates on agronomic crop production. Agronomic Crops: Volume 1: Production Technologies. 2019, 131-147.
5. Amarjeet A, Singh B, Kumar J, Kumar M, Sharma R, Kaushik P. Effect of sowing date, seed rate and row spacing on productivity and profitability of barley (*Hordeum vulgare*) in north India; c2020.
6. Ajaj HA, Mohammed YA, Alrubaya AA, Addaheri AM. Effect of Planting Dates on the Growth, Yield and Quality of Three Cultivars of Sorghum (*Sorghum bicolor* L. Moench). In IOP Conference Series: Earth and Environmental Science. 2021;904(1):012019. IOP Publishing.
7. Ahmad M, Chattha MU, Khan I, Chattha MB, Anjum FH, Afzal S, *et al*. Effect of different sowing dates and cultivars on growth and productivity of mungbean crop. Journal of Innovative Science. 2021;7(1):190-198.
8. Alam MS, Patel RKJN. Effect of sowing dates and varieties on the nutrient uptake and economics of Wheat crop (*Triticum aestivum* L.) under changing climate; c2022.
9. Baloch MS, Shah ITH, Nadim MA, Khan MI, Khakwani AA. Effect of seeding density and planting time on

growth and yield attributes of wheat. J. Anim. Plant Sci. 2010;20(4):239-242.
10. Bashir MU, Akbar N, Iqbal A, Zaman H. Effect of different sowing dates on yield and yield components of direct seeded coarse rice (*Oryza sativa* L). Pak. J Agri. Sci. 2010;47(4):361-365.
11. Buriro M, Bhutto TA, Gandahi AW, Kumbhar IA, Shar MU. Effect of sowing dates on growth, yield, and grain quality of hybrid maize. Journal of Basic & Applied Sciences. 2015;11:553-558.
12. Bachhao KS, Kolekar PT, Nawale SS, Kadlag AD. Response of different wheat varieties to different sowing dates. Journal of Pharmacognosy and Phytochemistry. 2018;7(1):2178-2180.
13. Biswas S, Debnath S, Saha A. Effect of plant density and nutrient management on yield and economics of maize (*Zea mays* L.) hybrids. International Journal of Bio-resource and Stress Management. 2022;13(1):37-44.
14. Bakal H, Onat B, Arioğlu H, Güllüoğlu L. The effect of sowing dates on the pod yield and some agronomic and quality characteristics of 'Virginia'-type peanut variety 'Halisbey'in the Mediterranean environment. Plant Introduction. 2022;1(93/94):27-36.
15. Chandini SA, Srivastava VK, Sankar A, Sahoo M. Effect of planting dates on dry weight, flowering and yield of different rice varieties. Journal of Pharmacognosy and Phytochemistry. 2020;9(1);1394-1397.
16. Chauhan SS, Singh AK, Yadav S, Verma SK, Kumar R. Effect of different varieties and sowing dates on growth, productivity and economics of wheat (*Triticum aestivum* L.). International Journal of Current Microbiology and Applied Sciences. 2020;9(2):2630-2639.
17. Duvick DN. The contribution of breeding to yield advances in maize (*Zea mays* L.). Advances in agronomy. 2005;86:83-145.
18. Fazily TAMIM, Habibi Ainullah. Performance of wheat varieties under different dates of sowing under irrigated condition of Baghlan province, Afghanistan. International Journal of Emerging Technologies and Innovative Research. 2019;6:50-53.
19. Fazily T. Effect of Sowing dates and seed rates on growth and yield of different wheat varieties: A review. Int. J. Agric. Sci. Technol. 2021;8:10-26.
20. Ganvit JB, Sharma S, Surve VH, Ganvit VC. Effect of sowing dates and crop spacing on growth, yield, and quality of linseed under south Gujarat condition. Journal of Pharmacognosy and Phytochemistry. 2019;8(1):388-392.
21. Habibi A, Fazily T. Effect of sowing dates on growth, yield attributes and yield of four wheat varieties. EPRA International Journal of Research and Development. 2020;5(1):56-59.
22. Inamullah NH, Shah ZH, FU K. An analysis of the planting dates effect on yield and yield attributes of spring wheat. Sarhad J. Agric. 2007;23(2):269-275.
23. Jarecki W, Bobrecka-Jamro D. Effect of sowing date on the yield and seed quality of soybean (*Glycine max* (L.) Merr.). Journal of Elementology, 2021, 26(1).
24. Khalifa AABA. Physiological evaluation of some hybrid rice varieties under different sowing dates. Australian Journal of Crop Science. 2009;3(3):178-183.
25. Karhale MB, Jaybhaye PR, Asewar BV, Shinde PB. Effect of different sowing dates on Growth and Yield of Kharif Sorghum Hybrids. Karnataka Journal of Agricultural Sciences. 2014;24(3):289-293.
26. Koca YO, Canavar O. The effect of sowing date on yield and yield components and seed quality of corn (*Zea mays* L.). Sci Papers Series A Agron. 2014;57:227-223.
27. Kumar P, Karle AS, Singh D, Verma L. Effect of high-density planting system (HDPS) and varieties on yield, economics, and quality of desi cotton. International Journal of Current Microbiology and Applied Sciences. 2017;6(3):233-238.
28. Mumtaz MZ, Ahmad M, Aslam M, Jamil M, Fakhar-u-Zaman M, Nasrullah HM, *et al*. Evaluation of growth and yield attributes of different wheat genotypes sown under various planting times. Evaluation, 2015, 5(19).
29. Oulmi A, Frih B, Guendouz A, Benkadja S. Effect of sowing date on grain yield, its components and some morpho-phenological traits of durum wheat (*Triticum durum* desf.) in semi-arid zone in Algeria. International Journal of Bio-resource and Stress Management. 2022;13(3):226-234.
30. Osmani MH, Fazily T, Kohshani B, Mirzaee M. comparison of adaptation assessment of four local spring wheat varieties in Kabul climatic conditions. s. no title author/s pages, 2020.
31. Praveen Km, Bm Madhu, Mehera Biswarup. Effect of different dates of sowing on growth and yield attributes of different cultivars of wheat (*Triticum aestivum* L.) under Allahabad condition. 2018;7:3443-3446.
32. Qamar R, Rehman A, Javeed HMR, Saqib M, Shoaib M, Ali A, *et al*. Influence of sowing time on cotton growth, yield and fiber quality. Int. J Biotech. 2016;13(1):59-67.
33. Samarah NH, Al-Issa TA. Effect of planting date on seed yield and quality of barley grown under semi-arid Mediterranean conditions. Journal of food agriculture and environment. 2006;4(2):222.
34. Shahzad MA, Sahi ST, Khan MM, Ahmad M. Effect of sowing dates and seed treatment on grain yield and quality of wheat. Pakistan Journal of Agricultural Sciences (Pakistan); c2007.
35. Sarhan HM, Abdou MAE, Al-Sayed HM. Effect of planting systems, plant density and nitrogen fertilizer levels on productivity and quality of sugar beet. Journal of Plant Production. 2012;3(10):2567-2580.
36. Shirinzadeh A, Heydari Sharif Abad H, Nourmohammadi G, Majidi Harvan E, Madani H. Effect of planting date on growth periods, yield, and yield components of some bread wheat cultivars in Parsabad Moghan. International Journal of Farming and Allied Sciences. 2017;6(4);109-119.
37. Sher A, Khan A, Cai LJ, Ahmad MI, Asharf U, Jamoro SA. Response of maize grown under high plant density; performance, issues and management-a critical review. Advances in Crop Science and Technology. 2017;5(3):1-8.
38. Saini LH, Trivedi SJ, Davda BK, Saini AK. Effect of sowing dates on growth, yield and economics of sorghum (*Sorghum bicolor* L. Moench) genotypes. Journal of Pharmacognosy and Phytochemistry. 2018;7(5):535-538.
39. Sobko O, Hartung J, Zikeli S, Claupein W, Gruber S. Effect of sowing density on grain yield, protein and oil content and plant morphology of soybean (*Glycine max* L. Merrill). Plant, Soil and Environment. 2019;65(12):594-601.

40. Soleymani A, Shahrajabian MH. Changes in seed yield and yield components of elite barley cultivars under different plant populations and sowing dates. Journal of Food, Agriculture and Environment. 2012;10(1):596-598.
41. Sharif I, Nazir A, Shahzadi E, Chohan SM, Sarwar G. Influence of Sowing Dates on Cotton Growth (*Gossypium hirsutum*), Yield and Fiber Quality. Pakistan Journal of Agricultural Research, 2020, 33(4).
42. Singh YP, Singh S, Dhangrah VK, Mishra T. Effects of Sowing Dates on Yield and Yield Components of Different Varieties of Wheat (*Triticum aestivum* L.) in Western Uttar Pradesh. International Journal of Economic Plants. 2021;8(4):188-192.
43. Tahir M, Ali A, Nadeem MA, Hussain A, Khalid F. Effect of different sowing dates on growth and yield of wheat (*Triticum aestivum* L.) varieties in district Jhang, Pakistan. Pak. J Life Soc. Sci. 2009;7(1):66-69.
44. Tanveer SK, Hussain I, Asif M, Mujahid MY, Muhammad S, Qamar M, *et al*. Performance of different wheat varieties/lines as affected by different planting dates and seeding rates under high rainfall area of Potohar. Pak. J Agri. Sci. 2009;46(2):102-106.
45. Tokatlidis IS, Haş V, Mylonas I, Haş I, Evgenidis G, Melidis V, *et al*. Density effects on environmental variance and expected response to selection in maize (*Zea mays* L.). Euphytica. 2010;174:283-291.
46. Tiwari P, Tiwari RK, Tiwari J, Yadav V. Effect of Sowing Dates on Physiological Parameters, Productivity and Economical Gain of Different Rice Varieties under Rainfed Condition. International Journal of Current Microbiology and Applied Sciences. 2018;7(2):2451-2457.
47. Umburanas RC, Yokoyama AH, Balena L, *et al*. Sowing Dates and Seeding Rates Affect Soybean Grain Composition. Int. J Plant Prod. 2018;12:181189 https://doi.org/10.1007/s42106-018-0018-y
48. Yan CP, Zhang YQ, Zhang DY, Dang JY. Effects of sowing date and planting density on the grain's protein component and quality of strong and medium gluten winter wheat cultivars. Ying Yong Sheng tai xue bao. The Journal of Applied Ecology. 2008;19(8):1733-1740.
49. Yang GZ, Luo XJ, Nie YC, Zhang XL. Effects of plant density on yield and canopy microenvironment in hybrid cotton. Journal of Integrative Agriculture. 2014;13(10):2154-2163.
50. Yusuf M, Kumar S, Dhaka AK, Singh B, Bhuker A. Effect of sowing dates and varieties on wheat yield and quality performance (*Triticum aestivum* L.). Agricultural Science Digest-A Research Journal. 2019;39(4):306-310.
51. Zand N, Shakiba MR. Effect of plant density and nitrogen fertilizer on some attribute of grain sorghum (*Sorghum bicolor* (l.) Moench). International journal of Advanced biological and Biomedical Research. 2013;1(12):1577-1582.
52. Zander A, Lofton J, Harris C, Kezar S.Grain sorghum production: Influence of planting date, hybrid selection, and insecticide application. Agrosystems, Geosciences & Environment. 2021;4(2):e20162.
53. Zhou C, Tuong ZK, Frazer IH. Papillomavirus immune evasion strategies target the infected cell and the local immune system. Frontiers in oncology. 2019 Aug 2;9:682.