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EFFECT OF DIFFERENT SOWING DATE ON PHENOLOGY, GROWTH AND YIELD OF RICE– A REVIEW

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Abstract

Rice being an important staple food crop of world, sowing date significantly influenced on growth and yield of rice crop, it has been studied by number of research workers from various parts of India and abroad. The sowing time of the rice crop is important for three major reasons. Firstly, it ensures that vegetative growth occurs during a period of satisfactory temperatures and total sunshine hours. Secondly, the optimum sowing time for each cultivar ensures the cold sensitive stage occurs when the minimum night temperatures are historically the warmest. Thirdly, sowing on time guarantees that grain filling occurs when milder autumn temperatures are more likely, hence good grain quality is achieved. Results from different studies revealed that the maximum yield potential of a rice crop is usually achieved when the crop is exposed to the most appropriate temperature range, which can be controlled by sowing at the proper time. In this paper an attempt has been made to critically review the research works carried out within the country as well as in abroad.

Key words: sowing date, rice, maximum yield potential, sowing time

Introduction

Rice grain consumed by nearly half the world's population, its grown in at least 114 countries and many people are engaged in rice cultivation around the world. Rice is the essential staple food for more than 65 per cent of the people, also plays a key role in food security and it provides employment and livelihood security to 70 per cent of Indian population. In India it grow in diverse conditions starting from below sea levels to hill as high as > 2000 meters. India is the second largest producer of rice in the world after China. It has an area of 43 million hectares with the production of 99 million tones and 3.45 t/ha productivity (Anon, 2012). In South Gujarat rice is cultivated in about 2,08,400 ha area with annual production of 3,80,300 tones and among these, Navsari district occupies 42,900 ha area with production of 92,200 tones (Kalariya, 2008). Recently weather variability is considered one of the major factors of inter-annual variability of crop growth and yield in all environments besides rainfall, temperature and bright sun shine hours also have been bearing on crop growth and development as well as yield response of different species to different environments, can be quite different. Shift in sowing dates directly influences both thermo and photo period, and consequently have great impact on the phasic development and partitioning of dry matter. Hence, the work of previous researchers and scientists relevant to sowing date has been gleaned from the different sources of literature over the years are collected and presented in a systematic way in this paper.

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Effect of sowing date on rice phenology

(Lee, *et al.* 1994) reported that the number of days from transplanting to maximum tillering decreased with delay in transplanting date under southern Alpine conditions. (Chopra, *et al.* 2006) reported that days to 50 and 100 per cent flowering were significantly affected due to delay in transplanting. For occurrence of 50 and 100 per cent flowering, maximum number of days were required in June 30 transplanting and difference of 7-10 days was observed between June 30, July 28 and August 4 planting. (Bali, *et al.* 1995) reported that irrespective of cultivars, maturity of different cultivars occurs at the same date when transplanted in 1st week of June. Results of field trials conducted in Wuling mountain area of China revealed that young panicle differentiation and heading dates were delayed at later sowing dates (Xie, *et al.* 1995). A field experiment conducted in Maharashtra by

(Dixit, *et al.* 2004) showed that panicle initiation stage started late in early sown crop (5th and 10th June) and 50 per cent flowering was earlier in late crop (25th June). Experiments conducted at two locations viz. Crowley and St. Joseph in Louisiana showed that days from seedling emergence to 50 per cent panicle emergence decreased at both locations as planting was delayed (Linscombe, *et al.* 2004). (Wani, *et al.* 2016) reported the days taken to reach flowering and harvest varied significantly among the sowing dates. The significantly higher number of days was taken by 15th SMW sown crop, however, was at par with 16th SMW crop while the significantly lowest number of days was taken by 18th SMW sown crop. (Nahar, *et al.* 2009) reported that low temperature causes various types of injuries in rice plants, but the most important one is spikelet sterility. Moreover, filled grains production decreased significantly with the delay of transplanting which was due to occurrence of low temperature at anthesis and spikelet primordial formation. (Singh and Singh 2000) from Uttaranchal reported that days taken to 75 per cent heading were not affected significantly by different sowing dates (15th March, 30th March and 15th April) but according to (Song, *et al.* 1996) in Korea reported that delayed sowing decreased the number of days from sowing to heading in rice different cultivars.

Effect of sowing date on growth and yield

The sowing time of the rice crop is important for three major reasons. Firstly, it ensures that vegetative growth occurs during a period of satisfactory temperatures and high levels of solar radiation. Secondly, the optimum sowing time for each cultivar ensures the cold sensitive stage occurs when the minimum night temperatures are historically the warmest. Thirdly, sowing on time guarantees that grain filling occurs when milder autumn temperatures are more likely, hence good grain quality is achieved (Farrell, *et al.* 2003). Rice seeded before the window of optimum dates usually has slow germination and emergence, poor stand establishment, increased damages from soil borne, seedling diseases under cold conditions and seeds lose by birds or mice (Linscombe, *et al.* 1999). Planting rice after the optimum dates can result in low yield due to higher disease and insect incidence, tropical storm-related lodging and possible heat or cold damage during heading and the grain filling period (Groth and Lee, 2003 and Reza, *et al.* 2011). Seedling at the time of transplanting is an important factor for uniform stand establishment of rice. On the other hand, if the age of seedlings is more than optimum, the seedlings produce fewer tillers due to the reduction of vegetative period and thereby result in poor yield. Among the crop production tools, proper time and method of sowing are the prerequisites that allow the crop to complete its life phase timely and successfully under a specific agro ecology (Vange and Obi, 2006, Bashir, *et al.* 2010). Sowing date also has a direct impact on the rate of establishment of rice seedling (Tashiro, *et al.* 1999). Early date of sowing is the best time of sowing for important properties such as maximum tillering, panicle initiation, chlorophyll content, leaf area index, sink capacity, panicle length, number of panicles m^{-2}, and grain yield (Khalifa, 2009). Delay in planting from15 June to 15 July decreased leaf area index (10%) (Rai and Kushwaha, 2008). At a specific location, maximum grain yield can be achieved by planting the crop at the optimum time, which may vary from variety to variety (Reddy and Narayana, 1984). Planting time is the major factor that determines the productivity of a crop. Optimum planting time for a crop is location specific. Optimum planting time worked out June 1-10 in Punjab (Gill, *et al*. 2006), June 15 at New Delhi (Narayanaswamy, *et al.* 1982) and June 5-15 at Cuttack (Chandra, *et al.* 1991). Early or delay in sowing leads to lower production of direct seeded rice. Optimum sowing time thus needs to be standardized for every ago-ecological situation for success of direct seeded rice. (Gravois and Helms, 1996) also showed that rice grain yields declined as seeding date was delayed. Early sown crops, despite poor germination, performed well due to better establishment an tiller production before water rose to higher depths in the field (Sharma, 1994). (Mahikar, *et al.* 2001) from a field experiment conducted in Akola, Maharashtra during *Kharif* on the effect of sowing time (15 June, 30 June and 15 July) on yield and yield attributes of rice cv. Para, have reported that sowing on 15 June gave the highest number of effective tillers (110.26/m row length), panicle weight (2.89 g), and grain yield (3252 kg/ha), and straw yield (6302 kg/ha). (Pandey, *et al.* 2001) noted that rice hybrid 'PA 6201' gave significantly higher productive tillers per hill and dry matter accumulation per plant of the crop transplanted on 20 July and 4 August than that the crop transplanted on 20 August. (Nayak, *et al.* 2003) conducted a field experiment on hybrid rice 'PA 6201', reported that early planting of 16 July exhibited the maximum total and effective tillers per clump, LAI and dry matter accumulation than that planting on 31 July and 16 August. One month delay in planting from 16 July reduced total tillers number, LAI and dry matter accumulation by 38, 13 and 18 per cent, respectively. (Dixit, *et al.* 2004) observed that rice crop planting on 25 June showed significantly more number of leaves at 60 DAS than that crop planting on 5, 10 and 15 June. (Safdar, *et al*. 2008) observed that plant height of different genotype of fine rice was affected significantly when assessed through the interaction of varieties and transplanting dates. Fine grain rice genotype 99521 showed the maximum plant height (195 cm) in 16th June transplanting date, which was significantly different from all other treatments combinations. Minimum plant height was recorded in Super basmati when transplanted on 16th may. Means of varieties across 6 transplanting dates showed that maximum number of grains per panicle (138.5) was recorded from genotype 99513 which was statistically similar with genotype 99512 producing 131.7 grains per panicle. On the other hand, maximum grains from single panicle (119.3), irrespective of variety, were counted from fine rice genotypes transplanting on 16th July which remained statistically at par with that transplanted on 1st July. (Annie, *et al.* 2009) observed that significantly highest effective tillers /hill, leaf area index (LAI) at flowering , filled grain / panicle, 1000 grain weight coupled with significantly lower sterility percentage were observed with 15 July planting during the rainy season. (Mannan, *et al.,* 2009) observed that plant height, tillers number, and dry matter of varieties varied significantly due to variation of transplanting dates. The short plants, less tillers, and low dry matter observed in early planted (22 July) crop and characters increased successive with the advances of planting date until 7-22 September and again declined thereafter irrespective of growth stages upto 60 DAT. (Singh and Singh, 2009) observed that grain yield of *boro* rice significantly varied due to age of seedlings. Transplanting of 70 days old seedlings recorded 60%, 11% and 25% more grain yield than that of 60, 80 and 90 days old seedlings, respectively. Early establishment coupled with superior growth and yield attributing characters resulted in more grain yield with 70 days old seedling. Maximum grain yield was recorded by transplanting of 4 seedlings hill^{-1} and proved significantly superior to 2 and 6 seedlings hill^{-1}. (Manjunatha, *et al.* 2010) reported that the grain yield of rice was significantly influenced by age of seedlings. Planting of 9 days or 12 days old seedling obtained significantly higher grain yield than 15, 18 and 21 days old seedlings. (Prabhakar and Reddy, 2010) observed the effect of dates of sowing and found that the 7th August transplanted crop was significantly shorter when compared to all other. The sowing of the nursery on 29th June has resulted in to significantly higher number of tillers when compared to sowing on 13 July. Among the dates of sowing the 29th June sown crop retained more LAI at 120 days after sowing. The biomass production was higher with 30th July sown crop when compared to the 13th August sown crop and was at par with rest of the sowing dates. The difference between the highest and lowest dry matter production was 317.2 gm^{-2}. (Balaswamy and Kulkarni, 2001) studied to determine the suitable planting time and rice cultivar for high grain yield. Thirty-day-old seedlings of rice cultivars Pakistan Basmati, Taraori Basmati, Pusa Basmati, and RNR 16511 were planted at 15 × 15 cm spacings (2 seedlings per hill) on 25 July, 10 August, 25 August, and 10 September. The highest grain yield of 2.93 and 3.67 t/ha were recorded in 1995 and 1996, respectively, when planted on 25 July. Crop performance was better in 1996 than in 1995. A linear reduction in grain yield was observed with every 15 days delay in planting from 25 July to 10 September. More number of panicles/m^2, panicle weight, and filled grains per panicle were recorded under 25 July planting. RNR 16511 gave significantly high grain yields of 2.95 t/ha in 1995 and 3.50 t/ha in 1996. (Nayak, *et al.* 2003) conducted a field experiment at Bhubaneswar during wet season of 1999 and 2000 to find out the response of hybrid rice 'PA6201' to dates of planting (16, 31 July and 16 August) and reported that a fortnight delay in planting from 16 July reduced the grain yield by 7.6 and 4.5 per cent during first year and second year, respectively. One month delay in planting from 16 July reduced the grain yield by 24.3 per cent. (Baloch, *et al.* 2006) reported that among transplanting dates, June 20th planted crop gave highest paddy yield and net return with 1 seedling hill^{-1}. It explains that the use of more seedlings hill^{-1} not only adds to cost but is also a mere wastage of natural resources. Based on research findings, we conclude that the use of 1 seedling hill^{-1} is most appropriate for timely sowing otherwise 4 seedlings hill^{-1} should be used to compensate for the yield gap in late transplanted rice. (Vange and Obi 2006) investigated the effect of planting dates on grain yield and some agronomic characters by early seeding (June 15 and June 30) and late seeding (July 15 and July 30). These indicated that planting date affected the performance of these traits significantly. Grain yield (t ha^{-1}) and plot yield (g) were highest on the July 30. (Arumugam, *et al*. 2007) study also indicated that sowing of long duration varieties could be extended up to July 1st fortnight and that of medium duration varieties up to 2nd fortnight of July instead of June 2nd fortnight and July 1st fortnight, respectively without significant reduction in grain yield. (Safdar, *et al.* 2008) reported that maximum number of fertile tiller hill^{-1} (19.1) was recorded in 1st June transplanting date, whereas, plant height (172.1 cm), grains panicle^{-1} (119.3), 1000 grain weight (21.58) and paddy yield (3.95 t ha^{-1}) were highest in 16th July transplanting dates, irrespective of genotypes. However, minimum paddy yield was recorded in 1st August transplanting date. Regarding rice genotypes, 99417 produced highest plant height (173.5 cm) and 1000 grain weight (23.88 g) but lowest paddy yield (2.82 t ha^{-1}), whereas, 98408 and

99513 gave maximum values of productive tillers hill^{-1} (24.64) and grains panicle^{-1} (138.5), respectively. Fine grain rice genotype 99512 showed best yield performance by producing 4.17 t ha^{-1} paddy yields. Therefore 16th July was 11 found to be the best date of transplanting and genotype 99512 showed best performance among all the genotypes studied.

Conclusion

The perusal of the literature suggests that sowing date is most pivotal which describe the rice yield to a major extent. The decreasing trend in grain yield with delayed sowing date might be associated with the reported significant lower number of filled grains per panicle, lower number of panicles m^{-2}, and lower test weight. Also there is a consensus in the literature that the synchronisation of the critical phenophases with the favourable weather regime ensures promising crop yield which is only possible by adjusting the sowing date. Therefore, it is imperative to confirm best sowing date for rice for higher yield levels and food security.

References

Annie, P., P. Swain and K.S. Rav (2009). Agro-physiological parameter of rice (*Oryza sativa*) hybrids as affected by different data of planting under costal Orissa. *Indian. J. Agric. Sci.,* **79(1)**: 25-28.

Anonymous (2012). www.agricoop.nic.in/Agricultural statistics

Arumugam, M., A.M.P. Rajan and B. Vidyachandra (2007). Stability of rice genotypes for yield and yield components over extended dates of sowing under Cauvery command area in Karnataka. *Oryza- An International Journal on Rice*, **44(2)**: 104-107.

Balaswamy, K. and N. Kulkarni (2001). Influence of time of transplanting on the performance of certain scented rice varieties in Andhra Pradesh. *Journal of Research ANGRAU,* **29(2/3)**: 98-101.

Bali, A.S., K.N. Singh, B.A. Ganai and B. Hasan (1995). Effect of transplanting date, number and age of seedling on rice. *Indian Journal of Agronomy*, **40(3)**: 504-507.

Baloch, M.S., I.U. Awan and G. Hassan (2006). Growth and yield of rice as affected by transplanting dates and seedlings per hill under high temperature of Dera Ismail Khan. *Pakistan Journal of Zhejiang University of Science,* **7(7)**: 572–579.

Bashir, M.U., N. Akber, A. Iqbal and H. Zaman (2010). Effect of different sowing dates on yield and yield components of direct seeded coarse rice (*Oryza sativa* L.) *Pakistan Journal of Agricultural Science,* **47(4)**: 361-365.

Chandra, D., B.T.S. Moorthy, K.P. Jha and Manna (1991). Agronomic practices for augmenting rice (*Oryza sativa*) production in rained rainfed ecosystem of Orissa. *Indian Journal of Agronomy,* **36**: 313-21.

Chopra, N.K., N. Chopra, R.N. Yadav and K.C. Nagar (2006). Effect of transplanting dates on seed yield and quality of paddy cv. Pusa-44. *Seed Research*, **34(2)**: 218-220.

Dixit, A.J., S.T. Thorat, V.V. Gaikwad and M.G. Jadhav (2004). Yield attributes and yield of parental lines of sahyadri hybrid rice as influenced by sowing dates. *J. Agrometeo.,* **6**: 95-97.

Farrell, T.C., K. Fox, R.L. Williams, S. Fukai and L.G. Lewin (2003). Avoiding low temperature damage in Australia's rice industry with photoperiod sensitive cultivars. Proceedings of the 11th Australian Agronomy Conference. Deakin University, Geelong (Feb. 2-6), Victoria, Australia.

Gill, M.S., A. Kumar and P. Kumar (2006). Growth and yield of rice (Oryza sativa) cultivars under various methods and time of sowing. *Indian Journal of Agronomy,* **51**:123-27.

Gravois, K.A. and R.S. Helms (1996). Seeding rate effect on rough rice yield, head rice and total milled rice. *Agronomy Journal,* **88**: 82-84.

Groth, D.E. and F.N. Lee (2003). Rice diseases. In C.W. Smith and R.H. Dilday (ed.) Rice: Origin, history, technology, and production. John Wiley and sons, Hoboken, New Jersey. 413-436

Kalariya, K.R. (2008). Molecular characterization and physiobiochemical responses to salt and ABA yield rice. Ph.D. Thesis, N.A.U., Navsari.

Khalifa, A.A.B.A. (2009). Physiological evaluation of some hybrid rice varieties under different sowing dates. *Australian Journal of Crop Science,* **3(3)**: 178-183.

Lee, D.J., Shim, I.S., J.H. Seo, K.J. Cho and J.C. Chae (1994). Growth and grain yield of infant seedling in rice as affected by different planting date in Southern Alpine area. RDA. *Journal of Agricultural Science Rice,* **36(1)**: 1-7.

Linscombe, S.D., D.L. Jordan, A.B. Burns and R.P. Viator (2004). Rice response to planting date differs at two locations in Louisiana. Online Crop Management.

Linscombe, S.D., J.K. Saichuk, K.P. Seilhan, P.K. Bollich and E.R. Funderburg (1999). General agronomic guidelines. In Louisiana rice production handbook. Louisiana State Univ. Agriculture Center, Crop Extension Service. Publication 2321. *Louisiana State University, Baton Rouge*, LA, p. 5-22.

Mahikar, G. H., D.V. Parmar and C.T. Pandey (2001). Effect of planting date on some agronomic traits and grain yield of upland rice varieties. *Journal of Sustainable Developement in Agriculture and Environment.*, **55**: 35-40.

Manjunatha, B.N., R. Basavarajappa and B.T. Pujari (2010). Effect of age seedling on growth, yield and water requirement by different system of rice intensification *Karnataka J. Agric. Sci.*, **23(2)**: 231-234.

Mannan, M.A., M.S.U. Bhuiya, S.M.A. Hossain and M.I.M. Akhand (2009). Study on phenology and yielding ability of Basmati fine rice genotypes as influenced by planting date in aman season. *J. Agril. Res*., **34(3)**: 373-384.

Nahar, K., M. Hasanuzzaman and R.R. Majumder (2009). Effect of low temperature stress in transplanted aman rice varieties mediated by different transplanting dates. *Academic Journal of Plant Sciences,* **2(3)**: 132-138.

Narayanaswamy, S., R.Y. Yoogeshwar, K. Ramsheshaiash and R.V. Sivasankaan (1982). Effect of time and method of sowing rice varieties in puddled soil during wet season. *Oryza.* **19**: 47-52.

Nayak, B.C., B.B. Dalei and B.K. Chodhury (2003). Respons of hybrid rice to date of planting, spacing and seedling rate during wet season. *Indian J. Agron.,* **48(3)**: 172-174.

Pandey, N., A.K. Verma and R.S. Tripathi (2001). Effect of planting time and nitrogen on tillering pattern, dry matter accumulation and grain yield of hybrid rice. *Indian J. Agril. Sci.*, **71(5)**: 337-338.

Prabhakar, S.V. and S.N. Reddy (2010). Effect of different dates of dry seeding and staggered nursery sowing on growyh and yield of *Kharif* rice. *Indian Journal of Agricultural Science,* **66(1)**: 48-50.

Rai, H.K. and H.S. Kushwaha (2008). Effect of planting dates and soil water regimes on and Mavarkar N.S. (2011). Effect of genotypes, planting geometry and method of establishment on growth and yield of aerobic rice. *Mysore journal of Agriculture Science*, **45(3)**:501-505.

Rai, H.K. and H.S. Kushwaha (2008). Effect of planting dates and soil water regimes on growth and Yield of upland rice. *Oryza - An International Journal on Rice*, **45(2)**: 129-132.

Reddy, S.N. and P. Narayana (1984). Pattern of dry matter accumulation and N uptake by rice as influenced by age of seedling and date of planting. *Andhra Agriculture Journal*, **32**: 155-56.

Reza, F., H.R. Mobasser, A.A. Dehpor and S.T. Kochaksarai (2011). *African Journal of Agricultural Research*, **6(11)**: 2571-2575.

Safdar, H.S., I.K. Hashmi and R.T. Malik (2008). Phsiological evaluation of some hybrid rice varieties under different sowing dates. *J. Agric. Res*., **56(8)**: 89 -93.

Safdar, M.E., A.A.S.M.G. Sarwar and T.H. Awan (2008). Effect of transplanting dates on paddy yield of fine grain rice genotypes. *Pakistan Journal of Botany,* **40(6)**: 2403-2411.

Sharma, A.R. (1994). Effect of different methods and timings of stand establishment on performance of rained lowland rice under 0-50 cm water depth. *Journal of Agronomy and Crop Science,* **172(1)**: 38-51.

Singh, U.P. and Y. Singh (2009). Effect of seedling age and number on yield of boro rice. *Indian J. Plant physiol.,* **46(2)**: 156-157.

Singh, V.P. and V.K. Singh (2000) Effect of sowing date and nitrogen level on productivity of spring sown rice (*Oryza sativa*) varieties in low hills of Uttaranchal. *Indian Journal of Agronomy,* **45(3)**: 560-563.

Song, Y., N. Oh and C. Hwang (1996). Growth and response of yield characters of dry seeded rice at different seeding dates in plain area. RDA. *Journal of Agricultural Sciences,* **38(2)**: 20-31.

Tashiro, T., M. Saigusa and K. Shibuya (1999). A Trial of No-tillage Direct Seeding of Rice (*Oryza sativa* L.) at Early Spring in Cold Climate Region in Japan. *Japanese Journal of Crop Science,* **68(1)**: 146-150.

Vange, T. and I.U. Obi (2006). Effect of planting date on some agronomic traits and grain yield of upland rice varieties at Makurdi, Benue state. *Nigerian Journal of Sustainable Development of Agriculture Environment,* **2(1)**: 1-9.

Wani, S.A., S. Qayoom, M.A. Bhat, B.A. Lone and A. Nazir (2016). Influence of sowing dates and nitrogen levels on growth yield and quality of scented rice cv. Pusa Sugandh-3 in Kashmir valley. *Journal of Applied and Natural Science,* **8(3)**: 1704-1709.

Xie, G.H., B.L. Su, S.L. Wang, X.C. Ma and Q.F. Wu (1995). A study on the growth and dry matter production of rice in Wuling mountain area 1. Effects of sowing dates on growth and development of rice. *Acta Agriculture Universitatis Pekinensis,* **21(3)**:259-264.