
REVIEW ARTICLE

REVIEW ON EFFECT OF VARIOUS PARAMETERS FOR ANALYSIS OF RICE YIELD

Vibha Chandraker¹, Pavani Veligatla² and Monoj K. Pradhan¹

¹Department of Agricultural Statistics and Social Sciences (L), Collage of Agriculture, Indira Gandhi Agricultural University, Raipur, Chhattisgarh, India

²Department of Genetics and Plant Breeding, Collage of Agriculture, Indira Gandhi Agricultural University, Raipur, Chhattisgarh, India
Email: chandrakervibha32@gmail.com

Received-06.04.2023, Revised-18.04.2023, Accepted-28.04.2023

Abstract: Climate amendment may be a change within the semipermanent weather patterns that characterize the regions of the world. The term “weather” refers to the short-run (daily) changes in temperature, wind, and/or rainfall of a region. within the long run, the environmental condition change may have an effect on agriculture in many ways in which resembling amount and quality of crops in terms of productivity, growth rates, photosynthesis and transpiration rates, wetness convenience etcetera Among the crops, rice is a sensitive crop that depends extremely on weather condition. If water isn't the limiting factor, the foremost necessary weather parameters are temperature and solar radiation. precipitation (spatial and temporal variation) is that the direct vital weather parameter in rainfed ecologies. once considering the expansion stages of rice, procreative and ripening stages are the foremost sensitive stages to weather. spike fertility is the most sensitive yield element when rice is subjected to worry viz., low or high temperature, low radiation or water deficit (drought). regulate the cropping schedule to cut back the chance of unfavourable weather throughout the reproductive and ripening stages. For getting high yields, every and each phenophase of rice ought to relish the favourable weather The review is especially confined to the influence of weather parts throughout completely different phenophase on growth, yield parts and yield of rice.

Keywords: Weather, Rice growth stage, Growth, Yield

INTRODUCTION

Rice is precise some of the essential cereals by distinctive feature of its volume and flexibility to wider variety of edaphic, climatic and cultural conditions. Though it's far a hydrophilic in nature and regularly cultivated as a semi aquatic crop, there are types and traces which are grown below dry or rainfed and semi dry condition. Climate determines the potential Production of rice types and those affects are manifested via plant characteristics like height, tillers, leaf region and range of panicle that in the long run determines the final grain yield.

Climate exchange can have important impact on crop increase, improvement and yield through increasing carbon dioxide, temperature and uncertainty in rainfall. The suit among environmental condition exchange and agriculture is a vital problem, since the global's meals producing assets are already at a lower place pressure as a result of a fleetly growing populace. It also can have an effect on the land use designs and therefore the productivity of crops.

Therefore, glorious experience of the strategies of modifications in climate and modifications on the expansion and improvement of crops is very important (Matthews and Wassmann, 2003). Environmental condition components which have temperature, rainfall, atmospherical CO₂ and radiation are vital parameters to rice producing. Associate degree growth in temperature variability and rain variability are situated to be useful and dangerous, severally to season and iciness rice yield however those variables have been nice still as insignificant for summer season rice.

Impact of CO₂: The primary primary result of CO₂ enrichment on plant is increasing photosynthesis. The second is to scale back stomatal aperture and density that causes a discount in stomatal electrical phenomenon and transpiration. The third primary effect is that the reduction of dark respiration. The ensuing effects of those primary responses to extend atmospherical CO₂ concentrations are increasing resource use efficiencies for radiation, water and chemical element and therefore increasing

*Corresponding Author

productivity of plant (Olesen and Bindi, 2002). In general, the direct effect of enhanced CO₂ levels is useful to vegetation (Baker *et al.*, 1990; Bowes, 1993; Farquhar, 1997).

Again, higher levels of greenhouse gas accelerate the event rates of rice plant. However, in rice growing underneath enhanced CO₂ conditions, at first, there's an oversized response so over time, this response decreases and go towards the rice growing under current CO₂ levels (Rowland-Bamford *et al.*, 1991).

“Sensitivity-analysis” of the result of CO₂ on potential rice yields, situations foretold by the GCMs represents the most effective estimates we've at the present of the possible changes in climate caused by a rise in CO₂ levels. (R.B Mathisews, 1995).

Reproductive biomass growth in addition as vegetative biomass growth are usually magnified by elevated carbonic acid gas. However, the harvest index, or the quantitative relation of seed yield to above-ground biomass yield, is often lower under neat elevated CO₂ conditions (Allen, 1991; Baker *et al.*, 1989), which can always be proof of the dearth of capacity to utilize utterly the more torrential photo assimilate. Specific respiration rates could also be reduced by each short exposure to elevated CO₂ and long grows that elevated CO₂. However, the long-term result could also be similar once respiration rates are reported one per unit gas basis. Change synonyms of colored words.

Impact of Rainfall: Climate change could modify precipitation, runoff, evaporation and soil wet strong. Changes in each total seasonal downfall and its pattern of variability are important (Olesen and Bindi, 2002). in an exceedingly hotter climate, the demand for water for irrigation are multiplied and so a lot of water will be required per unit space beneath drier conditions. Malabayoc *et al.* (1993) found that, throughout the generative stage, rainfall will make a case for 38-67% of upland rice yields variation within the Philippines. Fact, in upland situation rice plant cannot keep going high yield production under low precipitation. Saito *et al.* Hu (2006). Saito *et al.* (2006) concertedly found that rice production is nearly all allied to quantity of downfall in every part of vegetation and producing growth stage. (Raju Guntukula and Phanindra Goyari-2020) discovered that the the rainfall are risk-enhancing factors in rice yield variance function. Similarly, get larger in a production area under rice crop has positive effect on yield changeability of rice.

Narayanan (2004) according that total rain throughout nursery stage was negatively correlate with rice grain yield in non-significant manner however with straw yield it had been significant and absolutely correlated. Throughout vegetative stage it was non-significant with grain yield, wherever because it showed a big Correlation statistics with straw yield. Water deficit during the vegetative stage reduces the plant height, tiller variety and leaf space

but the crop will recover while not a lot of loss in yield if water is accessible before flowering.

Girish and Hittalma (2004) observed that wetness stress when ten days of fifty per cent the time of flower formation considerably reduced single raceme weight, check weight, fertile spikes per panicle, total spikelets per panicle and spikelet density and significantly redoubled sterile spikelets per panicle. It indicates 10 days after 50 per cent flowering to be the foremost crucial stage for grain filling. Among the rice growth stages, panicle initiation stage is a lot of sensitive to moisture stress.

Gupta *et al.* (2000) explained the yield variations in rain fed rice by quantum of precipitation throughout the vital vegetation formation and fruit setting phases. Deficit soil wet during grain filling stage drastically reduces the grain yield.

In Asian nation the kharif rice harvest was found lower once total June-September precipitation was not up to the future average traditional (Kumar *et al.*, 2004) and such results were in accordance with those of Webster *et al.*, (1998) and Selvaraju (2003). Weather-rice yield relationship for India explicit that enlarged weather extremes and lower rainfall along side different climatic parameters are leading to a decrease of rice yield (Krishnamurthy *et al.*, 2009 and Lal *et al.*, 1998).

Low precipitation plus high temperature adversely affects the yield of cereals (Bhandari, 2013) and also the grain yield slashed because the quantity of water applied decreased (Islam *et al.*, 1997). Variability in affects the stand institution and growth period of the crop (Kamalam *et al.*, 1988). Samui (1999) created a study of growth and yield of 1 high yielding and 4 ancient sensitive rice cultivars grownup throughout the kharif season beneath rainfed conditions at four sites of Asian nation with completely different rainfall and temperatures. The tracheophyte technique was accustomed examine the influence of earth science parameters on yield of rice. His results rumored that, the most rice yield was ascertained once average precipitation ranged between 100-115 cm.

Auffhammer *et al.*, (2011) opined that monsoon rainfall isn't the sole weather variable poignant the kharif rice yield in India. Their applied mathematics analysis of state-level Indian knowledge confirms that drought and extreme rainfall negatively affected rice yield in preponderantly rainfed areas throughout 1966–2002, with drought having a way larger impact than extreme precipitation. Results from the study counsel that total Gregorian calendar month–Gregorian calendar month rainfall is incredibly crucial for crucial the yield of the crop, applied mathematics results obtained from the experiment clearly indicate that this variable (i.e., total rainfall throughout June to September) is considerably correlative with rice yield which it may be accustomed generate a straightforward drought indicator that's additionally significantly correlated

with yield. Moreover, simulation results indicated that changes in total June–September precipitation and drought frequency had regarding equal impacts on rice yield throughout 1966–2002. Increase in rice yield attributable to enhancements in farming technology are part offset by the ascertained changes in weather over the amount 1966-2002 (Auffhammer *et al.*, 2012). On the contrary, for a few cultivars reminiscent of Jaya, yield slashed with increase in total rainfall during planting to maturity from 900 to 1100 millimetre (Samui, 1998). Change synonyms of colored words.

Impact of Temperature: In numerous elements of the world, global climate change might result on} agriculture differently. It depends on current environmental condition and soil conditions, the direction of change and therefore the convenience of resources and infrastructure to face with change.

The foremost effect of temperature on crop growth is to manage the length of the amount once growth is feasible in every year. Furthermore, temperature may directly affect the opposite processes related to the buildup of dry matter similar to leaf space expansion, respiration and chemical process (Olesen and Bindi, 2002).

Rice is very liable to extreme temperature particularly at flowering stage, the general effects of multiple climate variables on yield rely on each the sensitivity of yield to the climate variables and therefore the magnitude of modification within the climate variables.

The rise in night temperature related to warming decreases the rice yield. Rice yield tends to be reduced by higher minimum temperature.

Coldness may be a major issue limiting rice growth and yield, and spermatophyte is one in all the biological process stages at that sensitivity to chilling stress is higher. Chilling stress triggers a series of changes in physiological and molecular processes and, leads to the buildup of reactive chemical element species (ROS) in plant cells. Indica varieties are typically sensitive to cold as compared with japonica.

Low temperature depresses the charge of germination and prolongs it beyond the perfect span of 6 days. High temperature of 35 °C or greater halted the germination due to immoderate breathing charge (Sreenivasan, 1985). Bardhan and Biswas (1983) stated that in advance than panicle initiation, leaf emerges about each four-five days, afterwards approximately 7-eight days. Temperature influences

the charge of leaf emergence. When the rice plant is grown at 20 °C, leaves emerge every five days. When it is grown at 25 °C, they emerge every four days in advance than panicle initiation. The charge of tillering in rice has a bent to boom because the temperature increases. The most favourable temperature for tillering is 25 -31 °C. The effect of temperature on tillering is laid low with the extent of sunlight (Mahbubul *et al.*, 1985). Under low mild conditions, a number of the tiller buds may not grow to be tillers because of lack of carbohydrate that is crucial for boom. Under those situations, low temperature also can produce greater tillers. When moderate is right enough, however, better temperature will boom tiller variety.

Rice is most sensitive to warm temperatures at heading and next most touchy at around 9 days before heading. One or 2 hours of high temperature at inflorescence includes a decisive impact on the incidence of sterility. Warm temperatures before or when thesis has an excellent deal abundant less impact on sterility. The excessive sterility is also as a consequence of failure of fertilization ensuing from the imperfect rending of reproductive structure or wilt of stigma caused by means that of excessive temperature and occasional humidity. High temperature desiccated pollens (Osada *et al.*, 1973). Sterility become increased at excessive temperature of 35°C (day) and 30°C (night) as a results of smaller pollens and non-dehiscence of anthers.

Maximum and minimum temperature may justify an outsized a part of variation in throughout the growing amount of the rice. It has implication that the increasing temperature would result the productivity of Rice negatively, within the state of Orisha (Sushilakaur and Ghasi Ram, 2008) the utmost temperature features an adverse impact on the yield variance of rice. This means that maximum temperature could be a risk-reducing issue for rice yield and therefore the minimum temperature are risk-enhancing factors in rice yield variance function. Similarly, a rise in cultivation space underneath rice crop has a positive effect on yield variability of rice.

In increasing temperature can have major affection on rice production in overall Philippines. and that they discovered that the for each degree Centigrade international temperature increase, global mean rice yields will decline by $3.2 \pm 3.7\%$ (Malte pure Stuecker, Michelle, Tigchelaar, Michael B. Kantar, 2018).

Table: Response of Rice to various Temperature at different growth stages

Growth stage	Critical temperature(°C)		
	Low	Optimum	High
Germination	10	20-35	45
Tillering	9-16	25-31	33
Panicle initiation	15	-	-
Anthesis	22	30-33	35
Ripening	12-18	20-25	30

Impact of Drought: Consistent with a study, wetness stress affects rice at morphological (reduced germination, plant height, plant biomass, range of tillers, varied root and leaf traits), physiological (reduced photosynthesis, transpiration, stomatal conductance, water use efficiency, relative water content, pigment content, photosystem II activity, membrane stability, carbon atom discrimination and abscisic acid content), organic chemistry (accumulation of osmo-protectant like proline, sugars, polyamines and antioxidants) and molecular (altered expression of genes that write transcription factors and defense connected proteins) levels and thereby affects its yield. The fruitful stage is stricken by reduced grain formation, restrained spore development at meiosis stage and raceme exertion, which may typically account for 70%-75% spike sterility beneath water stress. It additionally inhibits processes comparable to reproductive structure dehiscence, spore shedding, pollen germination, and fertilization.

The temperature sensitivity of crops depends on growth stage, time of day, and time of year, however usually a temperature increase of 1 degree can decrease yields by up to 10% once a temperature threshold is reached in rice. (Malte pure Stuecker, Michelle Tigchelaar, Michael B. Kantar).

Impact of Solar Radiation: Due to heavy cloudiness at some stage in the developing duration in the tropics, period of vivid sunshine hours is ready 3-four hours day⁻¹ and yield of rice on this area is low (1.5-2.5 t ha⁻¹). Rice yield at some stage in summer time will become nearly double of that of monsoon season in Jap and southern India while it will increase marginally in Punjab (Biswas, 1996). Solar radiation intercepted in rice cover performs a prime role in figuring out biomass and grain yield. Solar radiation necessities of a rice crop fluctuate with the phenophases. Relationship among yield and sun radiation at different phenophases confirmed that excessive affiliation among one hundred and 450 cal cm⁻² day⁻¹ at some stage in reproductive degree and one hundred fifty and 400 cal cm⁻² day⁻¹ at some stage in ripening section and a susceptible relationship at 2 hundred cal cm⁻² day⁻¹ at some stage in vegetative section (Yoshida, 1981).

In Vegetative stage: low mild depth throughout the vegetative degree slightly affected the yield and yield additives of rice (Yoshida, 1981). Kamalam *et al.* (1988) said that amassed sunshine hours throughout tillering degree had a big positive correlation with the grain yield. A lengthy vegetative length and excessive radiation throughout this era is commonly useful for tillering.

In Reproductive stage: Yoshida and Parao (1976) rumored that radiation and temperature throughout fruitful stage (before flowering) had the best influence on rice yield as a result of they confirm the quantity of spikelets m⁻². PerStansel (1975), the

foremost important daylight requiring amount was round the heading stage throughout this period, a mean yield reduction of 6.5 per cent was discovered for each one per cent reduction in star radiation. The low strength up to flowering in kharif, obligatory a ceiling on tillering and dry matter production as compared to rabi season (Venkateswarlu *et al.*, 1977). Reduced star radiation throughout this stage strangled raceme heading. Low strength from ten days before heading to twenty days once blossoming elicited high spike sterility resulting in poor grain yield (Murty and Murty, 1982). Low lightweight stress reduced grain range panicle-1 briefly length varieties, inflated spikelet sterility in medium duration varieties and small panicle number in long duration varieties (Murty and Sahu, 1987), spike sterility below low lightweight at flowering was associated with decrease in saccharide content, supermolecule synthesis and growth regulator accumulation and increase in gibberellins and soluble N within the raceme. Shading at panicle initiation caused the plants to grow better. On the contrary, the tiller more and more got weakened and unproductive. This was notably true just in case of secondary and tertiary tillers. It ends up in reduction of DMP and panicles m⁻² (Thangaraj and Sivasubramanian, 1990).

Ripening stage: (WMO, 1983), Chauhan (1994) reportable that the major detail to be complete of growing shading depth become filled grain proportion while test weight remained unaffected. It appears that sun radiation affects grain filling and consequently filled grains via way of means of dominant deliver activity. Yoshida and Parao (1976) reportable that radiation at some point of ripening amount has the wonderful have an effect on on grain yield. Sreedharan (1975) opined that the yield attributes and grain yield recorded reciprocity information with star strength at some stage in ripening degree. At low light-weight depth, chemical alternate can become low inflicting mortality of the weak and unproductive tillers at some stage during this component as shortly as there waster concern for photosynthates from the growing grains (Thangaraj and Sivasubramanian (1990) determined that stuffed grains % and check weight are diminished thanks to depth stage or shading at some point of ripening degree, consequently it finally finishes up in yield discount. Dry count variety accumulation at some stage in publish flowering become additional in dry than in damp season at some stage in ripening degree, that become owing to higher radiation and concern of growing sink (Narasingarao, 1987). The discount in grain vary in line with flower cluster via method of means of shading of the vegetation from flowering to realize is just owing to unhealthy grain filling, that become obvious from the excessive sterility proportion (Patro and Sahu, 1986). A high-quality qualitative analysis between 300-600 cal cm⁻²

2 day⁻¹ radiation at some point of publish flowering and 50-a hundred and eighty stuffed grains in line with flower cluster become discovered via method of suggests that of Oldeman *et al.* (1987).

Analysis that accumulative radiation of 14,000 g cal cm⁻² and hundred hours of star surpass some stage in thirty days previous to harvest is only for buying most grain yield. High diffuse radiation at some stage during this degree reasons hopper burns amongst kharif plants thanks to ammonia toxicity as shortly because the sky is overcast with life-size clouds. at some point of this period, the stomata of plant live closed. Fuel line accumulates in vegetation and work ammonia (Nathan, 2003). Therefore, overcast skies with subtle radiation considerably at some stage in flowering of rice and forty five days previous its harvest have a tendency to decrease the grain yield (Chauhan, 1994) reportable that the major detail to be complete of growing shading depth become stuffed grain proportion whereas check weight remained unaffected. It seems that sun radiation affects grain filling and consequently filled grains via method of means of dominant deliver activity.

Impact of Relative Humidity: Relative humidity could be a perform of temperature associate moisture within the atmosphere is invariably way more in the morning than in the afternoon. Rice that is cultivated in the standing water builds up an atmosphere with high relative humidity.

Vegetative stage: Rice needs a reasonably high degree of humidity for correct growth. RH of 80-85 per cent is good for shoot growth. Rice fully grown at 22, 28 or 34 °C, the photosynthetic rate is increased with increase in humidity and contrariwise. The rise is greatest at 28 °C and smallest at 34 °C. Leaf temperature and stomata aperture within the higher a part of the cover conjointly hyperbolic with increasing humidity. Root dry weight production was additional influenced by RH than shoot dry weight. The root-shoot dry weight of plants at 90 % was lowest at coldness however higher at high temperature than in plants fully grown at 60% RH. At the intermediate temperature, RH had very little impact on root-shoot dry matter magnitude relation. Low ratio of sixty per cent iatrogenic a decrease in wet content, loss of pigment and quicker senescence of leaf. gas uptake and content of leaves and roots in plants fully grown at ninety per cent RH were on top of those of the plants grown in 60 per cent RH. Increase in relative humidity throughout active till ring increase the number of panicles per hill. High relative humidity with high star radiation absolutely influenced the number of leaves per plant. Low ratio shortened the times taken from transplantation to raceme initiation (Sunil, 2000).

Reproductive stage: Relative humidity plays a serious role in sterilization the times to initial flowering (Rangasamy, 1996). The minimum relative humidity needed for flowering of rice was 40%; the optimum being 70-80 per cent. If the RH is below 40

per cent, flowering is strangled. Wang *et al.* (1992), length of lemma closing in rice attenuated with increase in relative humidity from sixty to one hundred per cent, ratio influences the speed of transpiration. The raised transpiration could influence the physiological method moving the yield. The yield attenuated with the increasing ratio throughout this part (Ghildyal and Jana, 1967). In areas with hot temperature and low relative humidity or cold with high humidity, bract didn't open and eventually resulted in poor viability of spore (Subbiah, 1996). Narayanan (2004) found that relative humidity had correlation with straw yield and direct correlation with grain yield during this stage. It suggests that relative humidity during this stage had profound influence on growth and yield of rice.

Ripening stage: Ratio was the foremost important meteorologic issue moving spike fertility in rice followed by mean temperature at three days once heading. Spike fertility was reduced with increasing RH (Shi and Shen, 1990). Krishnakumar (1986) determined that relative humidity showed a negative relationship with panicles m⁻², grains m⁻², share of stuffed grains and grain yield. Low relative humidity (around 43%) throughout grain formation with a temperature varies of 12-13 °C was causative to yield increase (Ghildyal and Jana, 1967). Narayanan (2004) found that ratio had correlation with each grain yield and straw yield throughout this stage however in a very non-significant manner.

CONCLUSION

Among the abiotic stresses, climate plays the dominant role in influencing the growth and yield of rice. The foremost necessary weather parts that influence growth, development and yield of rice are solar radiation, temperature and rainfall. Relative humidity and solar radiation influence the crop growth to some extent. Paddy cultivation continues to be a risky enterprise, despite advances created in fashionable technologies. The deviation within the weather is often exploited by resorting to optimum time of sowing or planting.

REFERENCES

Auffhammer, M., Ramanathan, V. and Vincent, J. R. (2012). Climate change, the monsoon, and rice yield in India. *Clim. Chang*, **111**(2): 411-424.

[Google Scholar](#)

Baker, J.T., K. Boote and L.H. Allen Jr. (1995). Potential Climate Change Effects on Rice: Carbon Dioxide and Temperature. In: Climate Change and Agriculture: Analysis of Potential International Impacts, Rosenweig, C., J.W. Jones and L.H. Allen, Jr. (Eds.). ASA, USA., pp: 31-47.

[Google Scholar](#)

Baker, J.T., L.H. Allen Jr. and K.J. Boote, K.J. (1992). Response of rice to carbon dioxide and temperature. *Agr. Forest. Meteorol.*, **60**: 153-166.

[Google Scholar](#)

Bhandari, G. (2013). Effect of precipitation and temperature variation on the yield of major cereals in Dadeldhura district of far western development region, Nepal. *Int. J. Of Plant, Animal Environ. Studies*.

[Google Scholar](#)

Biswas, B.C. (1996). Link between climatic variability and agricultural production. In: Climate variability and agriculture. (Eds. Abrol, YP, Gadgil, S, Pant, GB). Narosa publishing house, New Delhi, 188-203.

[Google Scholar](#)

Chauhan, J.S. (1994). Effect of different temperature regimes and low light stress during ripening stage on yield of rice. *Madras Agric. J.*, **81**(5):243-245.

[Google Scholar](#)

Dwivedi, S.K., Kumar, S., Prakash, V., Mondal, S. and Mishra, J.S. (2015). Influence of rising atmospheric CO₂ concentrations and temperature on morpho-physiological traits and yield of rice genotypes in sub humid climate of Eastern India. *AJPS* **6**: 2239.

[Google Scholar](#)

Ghildyal, B.P. and Jana, R.K. (1967). Agrometeorological environment affecting rice yield, *Agron, J.*, **59**:286-287.

[Google Scholar](#)

Girish, R.S. and Hittalmani, K.L. (2004). Influence of climatological factors on rice under different water management practices. *Field crop Abst.*, **26**: 1664.

[Google Scholar](#)

Hi, C.H. and Shen, Z.T. (1990). Effect of high humidity and low temperature in spikelet fertility in indica rice. *IRRN*, **15**(3):10-11.

[Google Scholar](#)

Islam, M. S., Haque, M. Z., Jabber, M. A., Basak, A. K. and Paul, N. K. (1997). Effect of simulated rainfall at reproductive to ripening stages on the growth and yield of transplant Aman Rice. *Ann. Bangladesh Agric.*, **7**(2): 105-110.

[Google Scholar](#)

Kamalam, J., Menon, P.K.G. and Koruth, A. (1988). Influence of weather parameters on wetland rice yields in Kerala. *Oryza*, **25**:365-368.

[Google Scholar](#)

Krishnakumar, V. (1986). Agrometeorological parameters and hydro-nutritional management practices on rice cultivars. Ph. D thesis, Tamil Nadu Agricultural University, Coimbatore.

[Google Scholar](#)

Krishnamurthy, C. K. B., Lall, U. and Kwon, H. H. (2009). Changing frequency and intensity of rainfall extremes over India from 1951 to 2003. *J. of Clim.*, **22**(18): 4737-4746.

[Google Scholar](#)

Kumar, K. K., Rupa, K. K., Ashrit, R. G., Deshpande, N. R. and Hansen, J. W. (2004). Climate impacts on Indian agriculture. *Int. J. Climatol.*, **24**: 1375-1393.

[Google Scholar](#)

Malte, F., Stuecker, Michelle, Tigchelaar and Michael, B. (2018). Kantar. Climatic variability impacts on Rice production in the Philippines.

[Google Scholar](#)

Murty, K.S. and Sahu, G. (1987). Weather and rice. IRRI, Philippines, 93-101.

[Google Scholar](#)

Murty, P.S.S. and Murty, K.S. (1982). Efficiency of 14C sucrose translocation in high and low sterile rice varieties under normal and low light conditions. *J Nuclear Agric. Biol.*, **11**:100-101.

[Google Scholar](#)

Narasingarao, C.H. (1987). Seasonal influence on growth and yield of rice varieties. *Oryza*, **24**:59-65.

[Google Scholar](#)

Narayanan, A.L. (2004). Relative influence of weather parameters on rice hybrid and variety and validation of CERES-Rice model for staggered weeks of transplanting, Ph. D thesis, Tamil Nadu Agricultural University, Coimbatore.

[Google Scholar](#)

Nathan, K.K. (2003). The variation of cloudiness and diffused solar radiation index during Kharif season. *J. Agromet*, **5**(2): 43-47.

[Google Scholar](#)

Oldeman, L.R., Seshu, D.V. and Cady, F.B. (1987). Weather and rice, IRRI, Philippines, 5-9.

[Google Scholar](#)

Patro B., Sahu (1986). Effect of low light at different growth stages of the crop on sink size. *Oryza*, **23**:123-125.

[Google Scholar](#)

Rangasamy, P. (1996). Role of crop physiology in improving agricultural productivity, new vistas for plant physiology research, TNAU, Coimbatore.

[Google Scholar](#)

Samui, R. P. (1999). A note on the weather and rice yield relationship at some stations in India. *Earth Planet Sci.*, **108**(4): 309-371.

[Google Scholar](#)

Samui, R. P., Chawdhary, A. and Vaidya, N.G. (1998). Influence of weather on yield of rice. *J. of Tropical Agri.*, **36** (1-2): 73-75.

[Google Scholar](#)

Selvaraju, R. (2003). Impact of El Nino-southern oscillation on Indian foodgrain production. *Int. J. Climatol.*, **23**: 187-206.

[Google Scholar](#)

Sreedharan, C. and Vamadevan, V.K. (1981). Fertilization of rice as influenced by weather conditions. *Tropical Ecol.*, **22**:246-255.

[Google Scholar](#)

Sreedharan, C. (1975). Studies on the influence of climatological factors on rice under different water

management practices. Ph.D. Thesis, Orissa University of Agriculture and technology, Bhubaneswar, India.

[Google Scholar](#)

Stansel, J.W. (1975). Effective utilization of sunlight. The Texas Agric. Expt. Station Res. Monograph, **4**:43-50.

[Google Scholar](#)

Sunil, K.M. (2000). Crop weather relationship in rice. M. Sc thesis, Kerala Agricultural University, Thrissur, Kerala.

[Google Scholar](#)

Thangaraj, M. and Sivasubramanian, V. (1990). Effect of low light intensity on growth and productivity of irrigated rice grown in Cauvery Delta region. *Madras Agric. J.*, **77**(5-6):220-224.

[Google Scholar](#)

Venkateswarlu, B., Prasad, V.V.V.S. and Rao, A.V. (1977). Effects of light intensity of different growth phases in rice. *Pl. Soil*, **47**:37-47.

[Google Scholar](#)

Wang, Z., Jim, Y.G., Gur, X.M.J.J., Pu, L.M. and Gao, Z. (1992). Study on the delayed lemma closing of florets of wild abortive rice male sterile lines, *Scientia Agricultura Sinica*, **25**(2):22-26.

[Google Scholar](#)

Webster, P. J., Magana, V. O., Palmer, T. N., Shukla, J., Tomas, R. A., Yanai, M. and Yasuna, T. (1998). Monsoons: processes, predictability, and the prospects for prediction. *J. Geophys Res.*, **103**: 14451–14510.

[Google Scholar](#)

Yoshida, S. and Parao, F.T. (1976). Climate and Rice, IRRI, Philippines, 471-494.

[Google Scholar](#)

Yoshida, S. (1981). Fundamentals of rice crop science, IRRI, Philippines.

[Google Scholar](#)

