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Short communication

Use of exposure factor as a tool in assessment of reduction of life-duration of rice cultivars under global warming

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Panicle initiation is held to be the end of vegetative phase in rice and is most often the earliest recorded parameter on sowing date trials on phenology of rice. From world-wide experiments on rice covering a wide range of varieties, weather regimes and cultural practices, Oldeman *et al*. (1987) reported that the differences in duration of rice varieties are mainly due to differences in duration of vegetative phase. Venkataraman (2017) had cited the observations of Reddy *et al.* (2004) and Jayapriya *et al.* (2016) to (i) confirm the finding of Oldeman *et al.* (1987) and (ii) conclude that the duration of reproductive phase in rice is a varietal attribute and is of the order of 55 ± 5 days.

As only the duration of vegetative phase of rice will be affected by variations in mean daily air temperature, Venkataraman (2017) has introduced the concept of exposure factor (EF) which is the fraction of duration of vegetative phase to the entire crop life period. Data of Reddy *et al.* (2004) show that growing degree days above a base mean air temperature of 10 ^{0}C for the phase from sowing to panicle initiation range from 1100 to 1500. Mean daily crop season temperature for rice range from 20 to 30 ^{0}C.

In view of the above Venkataraman (2017) has given EF values of rice for varieties with growing degree days requirement above 10 ^{0}C for the vegetative phase of 1000 to 1500 in steps of 100 with a fixed reproductive duration of 55 days for 20 to 30 ^{0}C in one degree steps with the provison that EF values be increased or decreased by 0.02, respectively per 5 days decrease or increase in reproductive phase duration from 55 days. For each temperature the per cent reduction in crop-life duration for crop with base temperature of 10 ^{0}C but fully temperature sensitive for increase of 1, 2 and 3 ^{0}C are also given with the suggestion that EF values from table as deduced had to be multiplied by the normal per cent reduction value to get the actual reduction.

Work by Neog *et al.* (2019) shows that the temperature insensitivity in rice will start from attainment of maximum tillering which is earlier to that of panicle initiation. The growing degree days (GDDs) above a base mean daily air temperature of 10 ^{0}C is seen to be about 800 for the early variety and about 1400 for the late variety. From the work of Reddy *et al.* (2004) the GDD range 0f 800 to 1400 reported from sowing to end of maximum tillering should adequately cover the range expected amongst rice varieties. The duration from maximum tillering to physiological maturity for the 2 varieties is seen to be around 60 days but can range from 40 days (Islam and Sikder, 2011) to 85 days (Chaudhari *et al.,* 2017)

The above called for fresh computation of EF values in relation to temperature insensitive phase (TIP) of 40, 60, 80 and 100 days for growing degree days of range of 800 to 1600 for the phase from sowing to attainment of maximum tillering. The same was carried out and are set out in Table 1. Values of (i) GDDs refer to the phase from sowing to attainment of maximum tillering & (ii) temperature is mean daily crop season air temperature. Also values of EF are interpolable between (i) GDDs for same value of RIP and (ii) TIPs for same value of GDD. So multiply appropriate value of EF by the corresponding value of percentage reduction to get the actual reduction.

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Table 1 : Values of exposure factor (EF), temperature insensitive phase (TIP) and normal percentage reduction due to increase in mean daily air temperature of rice varieties

Air	40 Days TIP					60 Days TIP					80 Days TIP					100 Days TIP					Normal % reduction		
temp. ^0C	800	1000	1200	1400	1600	800	1000	1200	1400	1600	800	1000	1200	1400	1600	800	1000	1200	1400	1600	$+1^0C$	$+2^0C$	$+3^0C$
20	0.67	0.71	0.75	0.78	0.80	0.57	0.63	0.67	0.70	0.73	0.50	0.55	0.60	0.64	0.67	0.44	0.50	0.55	0.58	0.61	9	17	23
21	0.65	0.69	0.73	0.76	0.78	0.55	0.60	0.65	0.68	0.71	0.48	0.53	0.58	0.61	0.64	0.42	0.48	0.52	0.56	0.59	8	15	21
22	0.63	0.67	0.71	0.75	0.77	0.53	0.58	0.63	0.66	0.69	0.46	0.51	0.55	0.59	0.62	0.40	0.45	0.50	0.54	0.57	8	14	20
23	0.60	0.66	0.70	0.73	0.75	0.50	0.56	0.61	0.64	0.67	0.43	0.49	0.53	0.57	0.61	0.38	0.43	0.48	0.52	0.55	7	13	19
24	0.59	0.64	0.68	0.71	0.74	0.49	0.54	0.59	0.63	0.65	0.42	0.47	0.52	0.55	0.59	0.36	0.41	0.46	0.50	0.53	7	13	18
25	0.57	0.63	0.67	0.70	0.73	0.47	0.53	0.57	0.61	0.64	0.40	0.45	0.50	0.54	0.57	0.35	0.40	0.44	0.48	0.52	6	12	17
26	0.55	0.61	0.65	0.69	0.71	0.45	0.51	0.55	0.59	0.63	0.39	0.44	0.48	0.52	0.55	0.33	0.39	0.43	0.47	0.50	6	11	16
27	0.54	0.60	0.64	0.67	0.70	0.44	0.50	0.54	0.58	0.61	0.37	0.42	0.47	0.51	0.54	0.32	0.37	0.41	0.45	0.49	6	11	15
28	0.52	0.58	0.63	0.66	0.69	0.42	0.48	0.53	0.57	0.60	0.35	0.41	0.45	0.49	0.53	0.31	0.36	0.40	0.44	0.47	5	10	14
29	0.51	0.57	0.61	0.65	0.68	0.41	0.47	0.51	0.55	0.58	0.34	0.40	0.44	0.48	0.51	0.30	0.35	0.39	o.43	0.46	5	9	14
30	0.50	0.55	0.60	0.64	0.67	0.40	0.45	0.50	0.54	0.57	0.33	0.39	0.43	0.47	0.50	0.29	0.33	0.37	0.41	0.44	5	9	13

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