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Growth and Yield of Wheat (*Triticum aestivum* L.) Varieties as Influenced by Different Sowing Dates under Bastar Plateau Zone of Chhattisgarh

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A B S T R A C T

A field experiment was conducted during the *Rabi* season of 2016-17, at the Instructional Farm, Shaheed Gundadhoor College of Agriculture & Research Station, Kumhrawand, Jagdalpur District- Bastar (Chhattisgarh). The soil of experimental site was sandy loam; it was low in organic carbon (0.41%) and available nitrogen (228.90 kg ha^{-1}) and medium in available phosphorus (12.26 kg ha^{-1}) and potassium (286.25 kg ha^{-1}) and acidic in reaction (6.1 pH).The experiment was laid out in spilt plot design with four sowing dates and four varieties of wheat. Four sowing dates *viz.* 15th November (D_1), 30th November (D_2), 15th December (D_3) and 30th December (D_4) were applied in main plot and four varieties *viz.* GW- 273 (V_1), Lok- 1 (V_2), Sujata (V_3) and Kanchan (V_4) in sub-plot and replicated 3 times. The results revealed that sowing on 15th December recorded significantly higher plant height (36.39 cm) at 30 DAS whereas sowing on 30th December recorded higher plant height (90.42 cm) at 60 DAS. Sowing on 15th November recorded significantly higher plant height (103.58 cm) at 90 DAS and (104.05 cm) at harvest. Varieties Sujata recorded significantly higher plant height (34.44 cm) at 30 DAS (92.87 cm) at 60 DAS, (118.26 cm) at 90 DAS and (119.12 cm) at harvest. Sowing on 30th December recorded significantly higher number of tillers m^{-2} (1000) at 30 DAS, whereas sowing on 30th November recorded significantly higher number of tillers m^{-2} (742.5). Sowing on 15th November recorded relatively higher number of tillers m^{-2} (767.5) at 90 DAS and (764.83) at harvest. Varieties Sujata recorded significantly higher number of tillers (951.67), (753.75), (764.92) and (761.50) at 30 DAS, 60 DAS, 90 DAS and at harvest respectively. Sowing on 15th November recorded significantly higher duration for CRI (21.42 day), panicle emergence (62.63 day), 50% flowering (67.58 day), milking (82.67 day) and maturity stage (111.42 day). As compare to sowing on 15th November, duration of wheat crop reduces by 4 day with sown on 30th November, 11 day with sown on 15th December and 19 day with sown on 30th December. Sowing on 15th November recorded significantly higher grain yield (40.50 q ha^{-1}), straw yield (31.98 q ha^{-1}), gross return (Rs. ha^{-1} 61763), net return (Rs. ha^{-1} 35498) and B: C ratio (2.35). Varieties GW-273 recorded significantly higher grain yield (38.70 q ha^{-1}), gross return (Rs. ha^{-1} 59018), net return (Rs. ha^{-1} 32903) and B: C ratio (Rs. 2.26)), whereas Sujata produced significantly higher straw yield (30.42 q ha^{-1}).

Introduction

India is second largest producer of wheat (*Triticum aestivum* L.) in the world after China (134.34 million tonnes) with about 12% share in total world wheat production. In India, wheat is grown on about 30.60 million hectare area with a production of 98.38 million tonnes and average productivity is 3216 kg ha^{-1} during 2016-17 (Anonymous, 2017) and it is a second most important staple food after rice. In Chhattisgarh wheat occupies 180.38 thousand hectares with a production of 279.59 thousand tonnes and average productivity is 1550 kg ha^{-1} during 2017-18 (Anonymous, 2018). The yield and quality of wheat grain is influenced by several factors such as soil, climate, variety, sowing

method, sowing time, sowing depth, seed rate, water & nutrient management, weed, insect & disease management, harvesting time and other agronomic practices etc.

The seeding or planting time of various field crops is governed not only by the environmental requirements for the crop but also necessary for avoiding the ravages of diseases and insect pests. Proper time of sowing helps cultivars to express its growth patterns to its full extent in a diverse setting of environmental dynamic beside genotype environmental interaction. Other environmental factors like temperature, rainfall, humidity, solar radiation and soil types also contribute much towards the variety performance under a given locality. In addition during too early sowing the temperature is above the optimum which deals to irregular germination caused by frequent death of embryos and decomposition of endosperm due to bacteria or fungi (Paul, 1992). Late planting results in poor tillering and more chances of winter injury (Joshi *et al*., 1992). Wheat like other cool season generally is seeded early in the season to permit maximum growth and development toward maturity before the advent of hot weather, drought and diseases.

Proper sowing time and varietal selection could be responsible for higher production. Appropriate sowing time of various field crops results in higher economic yield without involving extra cost as it helps varieties to express their full growth potential. The sowing time of wheat crop plays a pivotal role in a country like India, where climatic conditions vary throughout the country and delay in sowing decreases wheat grain yield by 58.2 percent (Muhammad *et al.*, 2010). Selection of optimum sowing date for a particular region vital to obtain high yield due variation among the weather conditions. At tillering stage, optimum sowing time could produce good crop growth that increases the cold tolerance. Time of sowing is one of the most important factors which govern the crop phonological development and total biomass production along with efficient conversion of biomass into economic yield. Both early and late sowing of wheat causes reduction in length of spike and number of kernel per spike. Delayed sowing of wheat crop is exposed to sub- optimal temperatures at establishment and supra-optimal temperatures at reproductive phases resulting into reduction of not only crop duration but also the yield (Sardana *et al.*, 1999). Cultivation of wheat in Bastar Plateau zone of Chhattisgarh mostly under rice- wheat cropping system. In this cropping system, sowing of wheat becoming late due to late harvesting of rice, and high moisture content in field. Temperature stress after anthesis cause drastic effect on grain yield production. Suitable varieties, timely sowing & irrigation, proper weed, insect and disease management etc. can increase production of wheat in the region. Among all practices sowing time and varieties majorly affect yield of wheat. Keeping in view the present study was conducted with aim to optimize sowing time for getting higher yield of wheat varieties under NARP zone- Bastar Plateau Zone of Chhattisgarh.

Materials and Methods

A field experiment was conducted during the *Rabi* season of 2016-17, at the Instructional Farm, Shaheed Gundadhoor College of Agriculture & Research Station, Kumhrawand, Jagdalpur District- Bastar (Chhattisgarh). The soil of experimental site was sandy loam; it was low in organic carbon (0.41%) and available nitrogen (228.90 kg ha^{-1}) and medium in available phosphorus (12.26 kg ha^{-1}) and potassium (286.25 kg ha^{-1}) and acidic in reaction (6.1 pH).The experiment was laid out in spilt plot design with four sowing dates and four varieties of wheat. Four

sowing dates *viz*. 15th November (D_1), 30th November (D_2), 15th December (D_3) and 30th December (D_4) were applied in main plot and four varieties *viz.* GW- 273 (V_1), Lok- 1 (V_2), Sujata (V_3) and Kanchan (V_4) in sub-plot and replicated 3 times. Recommended dose of nutrients was 120:60:40 kg N: P: K ha^{-1}. Entire quantity of phosphorus & potassium was applied before sowing. Nitrogen applied in three splits *i.e.* 50% as a basal, 25% at tillering and 25% at panicle emergence stage. Experiment was conducted under irrigated condition and irrigated 5 times in different crop stages. Crop seed sown on different dates with a row spacing of 20 cm and seed rate was 125 kg ha^{-1}. Herbicide pendimethalin 37.8 CS applied @ 0.660 kg ha^{-1} in 3rd day of sowing. The average maximum and minimum temperature varied between 24.26^0c - 39.2^0c and 9.33^0c - 17.50^0c respectively.

The plant height was measured randomly of 5 plants of each plot in centimeter from ground surface up to the tip of awn. The number of tillers counted from 0.25 m^2 area by placing a quadrate of 0.5 m x 0.5 m randomly at 4 places in each plot and then number of tillers m^{-2} worked out. Occurrence of crop stages recorded by visited every day at experimental site. The harvest index was calculated by dividing the grain yield with biological yield (grain + straw yield) and multiplied by 100.

$$\text{Harvest Index (\%)} = \frac{\text{Grain yield (q/ha)}}{\text{Biological yield (q/ha)}} \text{X100}$$

Results and Discussion

Plant height

Average plant height increased progressively with increase in the age of the crop. The plant gained height at relatively slower rate between 90 DAS to at harvest and accelerated between 30 to 90 DAS. The Plant height of wheat influenced significantly due to sowing dates and varieties (Table 1). Among the sowing date treatments, sowing on 15th December recorded significantly higher plant height (36.39 cm) at 30 DAS followed by 30th December (33.12 cm), while sowing on 30th December recorded higher plant height (90.42 cm) at 60 DAS followed by 15th December (86.75 cm). Sowing on 15th November recorded significantly higher plant height (103.58 cm) at 90 DAS and (104.05 cm) at harvest followed by sowing on 30th November (100.68 cm) and (101.63 cm) respectively

Among the varieties Sujata recorded significantly higher plant height (34.44 cm) at 30 DAS, (92.87 cm) at 60 DAS, (118.26 cm) at 90 DAS and (119.12 cm) at harvest followed by GW-273 (33.14 cm) at 15 DAS, (82.24 cm) at 60 DAS, (93.57 cm) at 90 DAS and (94.73 cm) at harvest. In case of varieties difference in plant height may be due to their genetic characters. Muhammad *et al.,* 2015 conducted experiment in Bahawalpur, Pakistan recorded significantly higher plant height (102 cm) of wheat with sown on 11th November.

Number of tillers

The number of tillers decreasing with increasing the crop age up to 60 DAS and increasing with increase the crop age up to 90 DAS, but the number of tillers at maturity slightly reduced. The number of tillers of wheat influenced significantly due to varieties and sowing dates at 30 DAS and 60 DAS, whereas number of tillers did not influenced significantly due to sowing dates at 90 DAS and at harvest (Table 1). Among the sowing dates, sowing on 30th December recorded significantly higher number of tillers (1000 m^{-2}) at 30 DAS followed by sowing on 15th December (821.25 m^{-2}), while sowing on 30th November recorded significantly higher number of tillers (742.5 m^{-2}) followed by sowing on 15th December (723.75 m^{-2}).

Sowing on 15th November recorded relatively higher number of tillers (767.5 m^{-2}) at 90 DAS and (764.83 m^{-2}) at harvest, followed by sowing on 30th November (748.67 m^{-2}) and (742.17 m^{-2}) respectively.

Number of tillers of wheat varieties influenced significantly at all the stages of crop growth. Among the varieties Sujata recorded significantly higher number of tillers m^{-2} (951.67), (753.75), (764.92) and (761.50) followed by Lok-1 (889.17), (697.5), (758.92) and (752.50) at 30 DAS, 60 DAS, 90 DAS and at harvest respectively. In case of varieties difference in number of tillers may be due to their genetic characters. Muhammad *et al.,* 2015 in Pakistan recorded significantly higher number of tillers m^{-2} (421) of wheat with sown on 11th November

Days to occurrence of crop growth stages

The days to occurrence of crop growth stages influenced significantly due to sowing dates and varieties. Days to occurrence of CRI, panicle emergence, 50% flowering, milking and maturity decreased as sowing was delayed from 15th November to 30th December (Table 2). Among the sowing dates, sowing on 15th November recorded significantly higher duration for crown root initiation (21.42 day), panicle emergence (62.63 day), 50% flowering (67.58 day), milking (82.67 day) and maturity stage (111.42 day) followed by sowing on 30th November for crown root initiation (20.92 day), panicle emergence (59.75 day), 50% flowering (64.92 day), milking (80.50 day) and maturity stage (107.75 day). As compare to sowing on 15th November, duration of wheat crop reduces by 4 day with sown on 30th November, 11 day with sown on 15th December and 19 day with sown on 30th December. Variety Sujata taken significantly more time for CRI (21 day), panicle emergence (62.75 day), 50% flowering (69.25 day), milking (83.33 day) and maturity (110.83 day) followed by Kanchan for CRI (20.42 day), panicle emergence (57.92 day), 50% flowering (63.33 day), milking (78.67 day) and maturity stage (101.33 day). Variety Lok-1 taken lowest duration for CRI (19.67 day), panicle emergence (54.50 day), 50% flowering (59 day), milking (74.42 day) and maturity stage (100.75 day).

In case of varieties difference in days to occurrence of crop growth stages may be due to their genetic characters. Wajid *et al.,* 2006 in Pesawar, Pakistan reported that days to heading decreased as planting were delayed from 1st November to 16th January. Similarly in Punjab, Pakistan (Muhammad *et al.,* 2015) recorded that days to booting, heading, anthesis and matutrity decreased as sowing was delayed from 1st November to 21st December.

Grain and straw yield and harvest index

The grain and straw yield significantly influenced due to sowing dates and varieties, (Table 3). Among the sowing dates sowing on 15th November recorded significantly higher grain yield (40.50 q ha^{-1}) and straw yield (31.98 q ha^{-1}) followed by sowing on 30th November recorded grain yield (36.17 q ha^{-1}) and straw yield (30.38 q ha^{-1}), whereas harvest index did not influenced significantly due to sowing dates.

Among the varieties GW-273 produce significantly higher grain yield (38.70 q ha^{-1}) followed by Lok-1 (36.0 q ha^{-1}), Kanchan (32.30 q ha^{-1}), and Sujata (29.90 q ha^{-1}). Variety Sujata produce significantly higher straw yield (30.42 q ha^{-1}) followed by Lok-1 (30.22 q ha^{-1}), GW-273 (26.49 q ha^{-1}) and Kanchan (25.08 q ha^{-1}). Harvest index significantly higher under variety GW-273 (60.10%) followed by Kanchan (56.47%), Lok-1 (54.33%) and Sujata (49.53%).

Table.1 Plant height and number of tillers at different stages of wheat varieties as influenced by sowing dates

Treatment	Plant height (cm)				Number of tillers (m^2)			
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
Sowing dates								
15th November	28.95	83.12	103.58	104.05	817.50	582.50	767.50	764.83
30th November	32.91	76.18	100.68	101.63	820.00	742.50	748.67	742.17
15th December	36.39	86.75	94.97	95.62	821.25	723.75	725.33	718.92
30th December	33.12	90.42	92.54	93.16	1000.00	718.75	720.00	714.42
SEm±	**1.35**	**2.73**	**2.09**	**2.05**	**16.34**	**28.33**	**33.12**	**33.86**
CD (P = 0.05)	**4.68**	**9.44**	**7.24**	**7.08**	**56.55**	**98.03**	**NS**	**NS**
Varieties								
GW-273	33.14	82.24	93.57	94.73	797.08	667.50	735.83	730.25
Lok-1	31.28	80.43	88.00	88.53	889.17	697.50	758.92	752.50
Sujata	34.44	92.87	118.26	119.12	951.67	753.75	764.92	761.50
Kanchan	32.50	80.93	93.08	93.93	820.83	648.75	701.83	696.08
SEm±	**0.48**	**1.15**	**0.74**	**0.77**	**25.47**	**14.76**	**12.78**	**13.03**
CD (P = 0.05)	**1.41**	**3.36**	**2.17**	**2.26**	**74.34**	**43.09**	**37.29**	**38.04**

DAS- Days After Sowing

Table.2 Occurrence of crop stages of wheat varieties as influenced by sowing dates

Treatment	Occurrence of crop stage (Day)				
	CRI	Panicle emergence	50% Flowering	Milking	Maturity
Sowing dates					
15th November	21.42	62.83	67.58	82.67	111.42
30th November	20.92	59.75	64.92	80.50	107.75
15th December	19.92	56.42	62.00	76.92	100.67
30th December	19.17	53.08	58.92	72.33	92.92
SEm±	**0.25**	**0.42**	**0.36**	**0.46**	**1.03**
CD (P = 0.05)	**0.88**	**1.46**	**1.25**	**1.60**	**3.55**
Varieties					
GW-273	20.33	56.92	61.83	76.00	100.83
Lok-1	19.67	54.50	59.00	74.42	100.75
Sujata	21.00	62.75	69.25	83.33	110.83
Kanchan	20.42	57.92	63.33	78.67	101.33
SEm±	**0.10**	**0.29**	**0.16**	**0.15**	**0.35**
CD (P = 0.05)	**0.29**	**0.87**	**0.47**	**0.45**	**1.01**

Table.3 Grain and straw yield, economics of wheat as influenced by sowing dates and varieties

Treatment	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest index (%)	Cost of cultivation (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B: C ratio
Sowing dates							
15th November	40.50	31.98	55.88	26265	61763	35498	2.35
30th November	36.17	30.38	54.35	26265	55159	28894	2.10
15th December	33.65	27.91	54.96	26265	51316	25051	1.95
30th December	26.60	21.93	54.75	26265	40565	14300	1.54
SEm±	**2.63**	**2.01**	**1.74**	-	-	-	-
CD (P = 0.05)	**9.09**	**6.96**	**NS**	-	-	-	-
Varieties							
GW-273	38.70	26.49	60.10	26115	59018	32903	2.26
Lok-1	36.00	30.22	54.33	26115	54900	28785	2.10
Sujata	29.90	30.42	49.53	26715	54568	27853	2.04
Kanchan	32.30	25.08	56.47	26115	49258	23143	1.89
SEm±	**1.01**	**1.41**	**1.55**	-	-	-	-
CD (P = 0.05)	**2.94**	**4.11**	**4.52**	-	-	-	-

Price of Seed: Rs. 2600 q^{-1} (GW-273, Lok-1 & Kanchan) and 3200 q^{-1} (Sujata)
Price of sold grain: Rs. 1525 q^{-1} (GW-273, Lok-1 & Kanchan) and 1825 q^{-1} (Sujata)

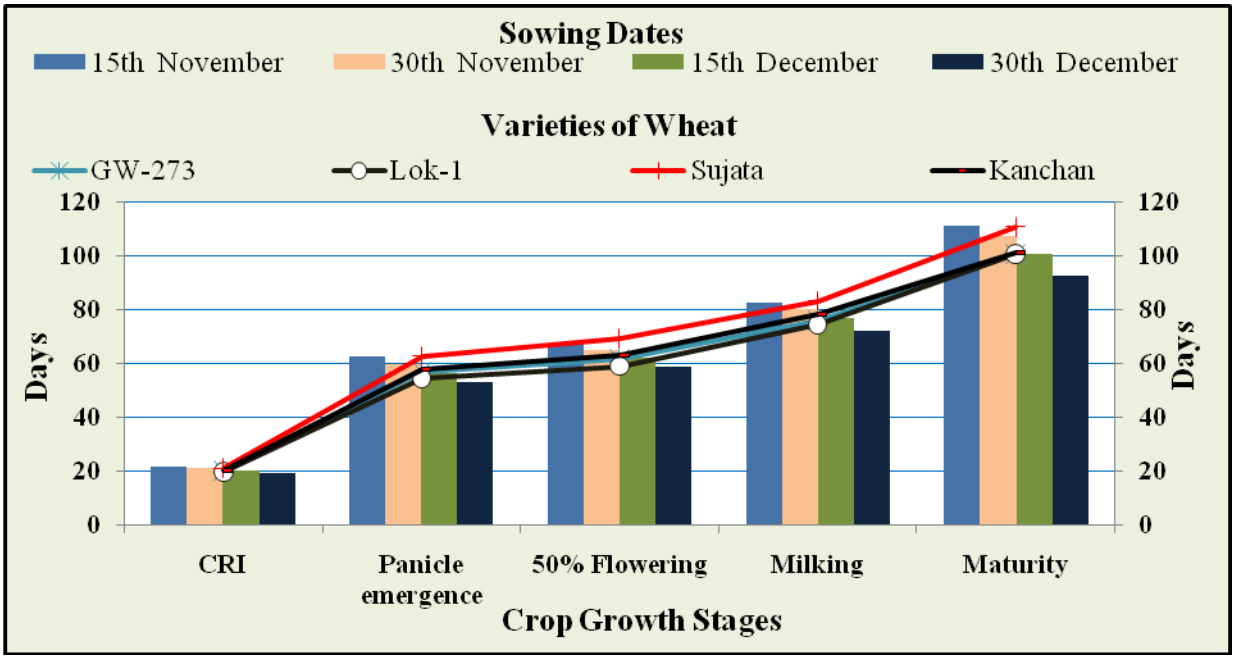

Fig.1 Occurrence of crop growth stages of wheat varieties as influenced by sowing dates

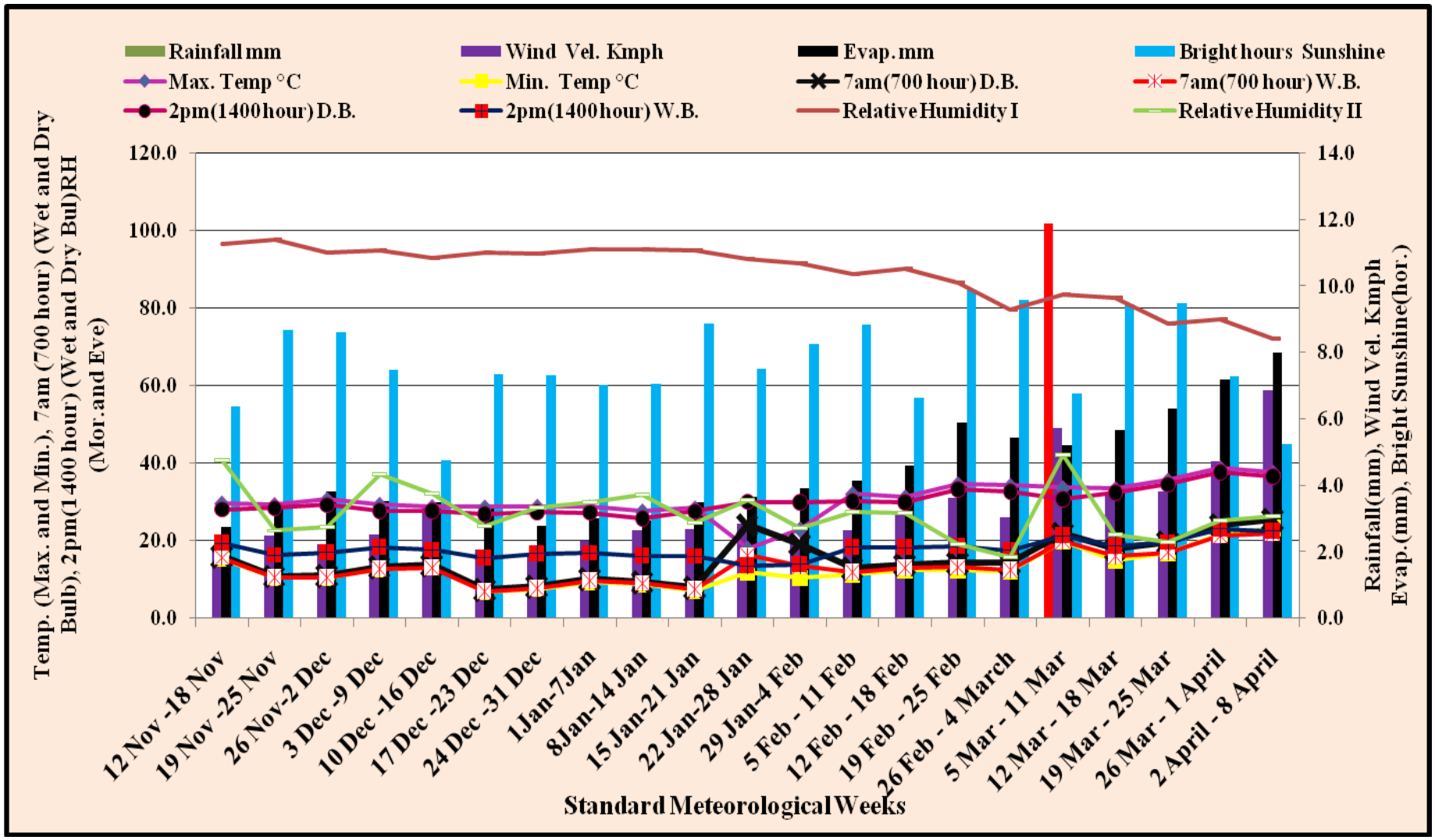

Fig.2 Weekly meteorological data prevailing during crop growth period (Rabi, 2016-17)

Higher grain yield of wheat variety GW-273 was mainly attributed due to higher number of effective tillers and other yield attributing characters. In case of varieties difference in grain and straw yield may be due to their genetic characters.

In Raipur, Chhattisgarh Chetal Lal, 2019 recorded that the varieties Sujata, Kanchan and GW-273 produced maximum grain yield (3837.5 kg/ha, 3670.0 kg/ha and 3643.3 kg/ha respectively), when sown on 06 December. Sardana *et al.,* 2002 recorded that delay in sowing from 15 November to 15 December decreased the wheat grain yield by 32.6 and 27.4% in 1997–98 and 1998–99 respectively at Punjab. Mukherjee *et al.,* 2018 conducted experiment at Jagdalpur, Chhattisgarh and recorded that 4250 kg ha^{-1}grain yield of wheat with sown on 1st December, whereas varieties not influenced significantly.

Economics of production of wheat varieties

Effect of different treatments cannot be assessed without the gross and net return from that treatment. The economics of different treatments have been presented in Table 3. Among the sowing dates sowing on 15th November recorded the highest gross return (Rs. ha^{-1} 61763), net return (Rs. ha^{-1} 35498) and B: C ratio (2.35) followed by sowing on 30th November, gross return (Rs. ha^{-1} 55159), net return (Rs. ha^{-1} 28894) and B: C ratio (2.10). Among the varieties, GW-273 recorded highest gross return (Rs. ha^{-1} 59018), net return (Rs. ha^{-1} 32903) and B: C ratio (Rs. 2.26) followed by Lok-1 with gross return (Rs. ha^{-1} 54900), net return (Rs. ha^{-1} 28785) and B: C ratio (Rs. 2.10).

On the basis of experimental findings, it is concluded that wheat should be sown from 15th to 30th November for obtaining higher yield of grain and straw and gross & net return. Wheat varieties GW-273 and Lok-1 should be sown for obtaining higher grain yield and gross & net return in the Bastar Plateau Zone of Chhattisgarh.

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