RESEARCH PAPER

ADVANCE RESEARCH JOURNAL OF
CROP IMPROVEMENT
Volume 8 | Issue 2 | December, 2017 | 165-171
e ISSN-2231-640X

DOI :
10.15740/HAS/ARJCI/8.2/165-171
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# Agronomic efficiency and economic viability of wheat crop under varied sowing environments in North Western Himalaya

KARAN VERMA, RANBIR SINGH RANA[1], SHIVANI THAKUR[1] AND PANKAJ CHOPRA[1]

AUTHORS' INFO
**Associated Co-author :**
[1]Department of Agronomy, Forages and Grassland Management, C.S.K. Himachal Pradesh Krishi Vishvavidyalaya, PALAMPUR, (H.P.) INDIA

**Author for correspondence:**
**KARAN VERMA**
Department of Agronomy, Forages and Grassland Management, C.S.K. Himachal Pradesh Krishi Vishvavidyalaya, PALAMPUR, (H.P.) INDIA
Email: karanverma2123@gmail.com

**A**BSTRACT : The study examines the suitable climatic windows in the face of climate change under limited irrigations under sub temperate climate. The field experiment in Randomized Block Design, comprising of four dates of sowing *viz.*, October 20, November 10, November 30 and December 20, and three genotypes *viz*., HPW-249, HPW-155 and HPW-42 in silty clay loam, acidic soil was conducted during *Rabi* session for two years at CSKHPKV, Palampur, Himachal Pradesh. The days taken to complete different phenophases were statistically at par amongst varieties, whereas DAS to vegetative stage and heading maturity were observed minimum reflecting lowest DAS for maturity in 20th December sowing. The growth and yield attributes *viz*., plant height, number of tiller $m^{-2}$, number of grains $tillers^{-1}$ and 1000-grain weight was highest in variety HPW-249 during both the years. Amongst sowing environments, October 20th sown crop gave significantly highest values of growth and yield during both the years. The periodic LAI recorded similar upto 60 DAS and thereafter, the highest values were recorded in HPW-249 upto physiological maturity. Amongst sowing environments, 20th October sown gave highest LAI during entire ontogeny of crop likewise yield attributes, grain and straw yield was highest in 20th October sown crops. Amongst variety HPW-249 gave highest grain yield to the tune of 43.0 in 2011-12 and 45.6 q/ha in 2012-13.The economic returns and benefit cost ratio were also significantly highest in HPW-249 (Rs. 75568 in 2011-12 and 81219 in 2012-13). Likewise, grain yield, net returns and B: C ratio were significantly highest in 20th October sown crop compared to subsequent dates of sowing.

**K**EY **W**ORDS : Time of sowing, Development studies, Yield, Periodic leaf area index, Economics

**H**ow to cite this paper : Verma, Karan, Rana, Ranbir Singh, Thakur, Shivani and Chopra, Pankaj (2017). Agronomic efficiency and economic viability of wheat crop under varied sowing environments in North Western Himalaya. *Adv. Res. J. Crop Improv.,* **8** (2) : 165-171, **DOI : 10.15740/HAS/ARJCI/8.2/165-171**.

**P**aper **H**istory : **Received :** 16.06.2017; **Revised :** 26.10.2017; **Accepted :** 11.11.2017

Wheat is the most important cereal crop because it is the staple food of the people of world and thus occupies a central position in forming agricultural policies and dominates all crops in acreage and production. Wheat (*Triticum aestivum* L.) is world's second important cereal crop after rice. India is second largest producer of wheat in the world after China with about 12 per cent share in total world wheat production. Area under this crop in India is 31.19 million hectare with a production of 94.49 million tonnes of production and 3.03 t/ha productivity (Anonymous, 2015). In Himachal Pradesh, this crop is presently being cultivated on 0.341 million hectare with a production of 680 thousand tones and productivity of $1.0 t/ha^{-1}$ (Anonymous, 2014). Plausible

climate change and variability have the potential to significantly affect the production of wheat positively and negatively depending upon the optimal temperature prevailing in those regions. The regions with sub optimal temperature would be benefitted and whereas productivity would decreased in region having optimal temperatures already existed. Owing to the plausible changes in climatic parameters in recent decades necessitate the assessment of best sowing environments for wheat according to changing climatic conditions under rainfed conditions. The best planting windows has proved to the new adaptations strategy in the face of climate change and such information are essential for after every decade to sustain the higher productivity. The agronomic information of crop under varied sowing windows also helpful in validation of crop growth simulation modelling. Crop models running in real time can furnish data on irrigation and nitrogen stress studies and monitor the growth, development and yield potential of the crop. Therefore, results obtained from different sowing environments can provide the data essential for modelling the crop yield under rainfed conditions in achieving greater accuracy in the field and increased efficiency in the inputs use.

## RESEARCH PROCEDURE

A field experiment was conducted for two years during (*Rabi* season of 2011-12 and 2012-13) at research farm of Department of Agronomy, CSK HPKV, Palampur (Himachal Pradesh), geographically, the experimental site is situated at $32^0 6'$ N latitude and $76^0 3'$ E longitude at an elevation of about 1290.8 m above mean sea level in North-Western Himalaya. The experiment was laid out in a Randomized Block Design (RBD) with the combination of four dates of sowing on October-20, November-10, November-30 and December-20 and three varieties, HPW- 249, HPW- 155 and HPW- 42, replicated three times. The soil of experimental area was silty clay loam in texture, acidic in reaction, medium in available nitrogen 316 kg $ha^{-1}$, medium in available phosphorus 16.7 $ha^{-1}$, medium in organic carbon 08 % and high in available potassium 298 kg $ha^{-1}$. The data were recorded on number of tillers $m^{-2}$, spike length (cm), plant height at maturity (cm), 1000-grain weight (g), grain yield (kg $ha^{-1}$) and analysed statistically using standard procedures. The crop was raised following recommended packages and practices. The pre-sowing irrigation was applied during both the years and limited two irrigations were applied in January and March during both the years.

## RESEARCH ANALYSIS AND REASONING

The findings of the present study as well as relevant discussion have been presented under following heads :

**Development studies :**

*Days to complete emergence :*

During *Rabi* season (2011-12) the data revealed that variety HPW-42 took significantly more number of days (14.0) for complete emergence stage followed by HPW-155 (11.9) and HPW-249 (11.8) (Table 1). Amongst dates of sowing, 20th December (13.3) sown crop took more number of days for complete emergence followed by 30th November (12.7), 30th November (12.2) and 20th October (12.0). In second year of field experimentation revealed that variety HPW-42 took 12.8 days for complete emergence followed by variety HPW-155 (12.0) and HPW-249 (11.8). Amongst dates of sowing, 20th December (12.8) took more number of days for complete emergence stage followed by 10th November (12.4), 20th October and 30th November.

*Days to vegetative stage :*

During first year field experimentation , the data revealed that variety HPW-249 took significantly more number of days (56.8) for days to vegetative stage followed by HPW-155 (55.5) and HPW-42 (54.8) (Table 1), Amongst dates of sowing, 20th October (65.7) took significantly more number of days to vegetative stage followed by remaining subsequent dates of sowing. During *Rabi* season (2012-13) the data revealed that HPW-42 took significantly more number of (53.7) days for vegetative stage followed by HPW-249 and HPW-42, Amongst dates of sowing, 20th October sown crop took significantly more number of days for vegetative stage (62.1) followed by 10th November, 30th November and 20th December.

*Days to heading :*

A perusal of data during *Rabi* season (2011-12 and 2012-13) revealed that variety HPW-249 took more number of (143.2), (139.8) days for heading stage followed by a HPW-42 and HPW-155 (Table 1). Amongst dates of sowing, 20th October took significantly number of days

(153.2) and (151.1) for heading stage followed remaining subsequent dates of sowing.

**Days to physiological maturity :**

A perusal of data in first year field experiment revealed that variety HPW-249 took significantly more number of days (162.3) for physiological maturity followed by a HPW-155 and HPW-42 (Table 1). Amongst dates of sowing, 20th October sown crop took significantly more number of days (176.3) to physiological maturity followed by 10th November, 30th November and 20th December sown crop. The data of second year of field experimentation revealed that variety HPW-249 took more number of days (158.8) to physiological maturity followed by HPW-42 and HPW-155. Amongst dates of sowing, 20th October sown crop (172.6) took significantly more number of days for physiological maturity followed by 10th November, 30th November and 20th December sown crop. Generally early planted wheat experiences smaller germination phase than late planting but days taken to start anthesis and booting stages notably decreased in late sown wheat due to elevated heat stress later in the season (Nahar *et al.,* 2010).

**Plant height (cm) :**

During *Rabi* seasons of 2011-12 and 2012-13, the data revealed that variety HPW-249 produced longer plant height 105.7 and 103.1 cm, respectively, followed by HPW-42 and HPW-249. Amongst dates of sowing, 20th October sown crop recorded significantly taller plant height 107 and 105 cm, respectively, followed by 10th November, 30th November and 20th December (Table 2).

**Tiller count :**

During both the years, results showed that variety HPW-249 produced significantly higher number of tillers (297 in 2011-12 and 302 in 2012-13) followed by HPW-155 and HPW-42. Amongst dates of sowing, 20th October produced significantly higher number of tillers (301 during 2011-12 and 312 during 2012-13) followed by 10th November, 30th November and 20th December (Table 2). This might be due to the early sowing and early emergence of crop and also because of optimum temperature during the different pheno-phases. Decline in number of tillers meter$^{-2}$ with successive delay in sowing was also reported by Prabhakar *et al*. (2007) and Kumar (2011) under similar agro climatic conditions. The sowing dates and varieties did not show interaction effects during both years.

**Number of grains tiller$^{-1}$:**

The data revealed that variety HPW-249 produced more number of grains tiller$^{-1}$ to the tune of 48.5 and 49.1 during crop seasons of 2011-12 and 2012-13, respectively as compared to varieties HPW-155 and HPW 42. Amongst dates of sowing, 20th October sown crop produced significantly more number of grains tiller$^{-1}$ to the tune of 48.2 during 2011-12 and 49.4 during second year followed by 10th November, 30th November and 20th December sown crop during both the years (Table 2).

**Leaf area index :**

The data on leaf area index (LAI) for wheat was

**Table 1 : Effect of varieties and dates of sowing on number of days taken to different phenological stage during 2011-12 and 2012-13**

| | Days to complete emergence | | Days to vegetative stage | | Days to heading stage | | Days to physiological maturity | |
|---|---|---|---|---|---|---|---|---|
| | 2011-12 | 2012-13 | 2011-12 | 2012-13 | 2011-12 | 2012-13 | 2011-12 | 2012-13 |
| **Variety** | | | | | | | | |
| HPW-155 | 11.9 | 12.0 | 55.5 | 51.8 | 137.2 | 133.8 | 159.9 | 156.8 |
| HPW-249 | 11.8 | 11.8 | 56.8 | 53.7 | 143.2 | 139.8 | 162.3 | 158.8 |
| HPW-42 | 13.2 | 12.8 | 54.8 | 52.3 | 137.8 | 138.4 | 159.3 | 157.2 |
| C.D. (P=0.05) | NS | NS | NS | NS | NS | NS | NS | NS |
| **Dates of sowing** | | | | | | | | |
| 20-Oct | 12.2 | 12.1 | 65.7 | 62.1 | 153.2 | 151.1 | 176.3 | 172.6 |
| 10-Nov | 12.2 | 12.4 | 59.5 | 55.2 | 143.7 | 140.1 | 169.6 | 165.4 |
| 30-Nov | 12.7 | 11.6 | 52.3 | 49.2 | 136.4 | 132.3 | 156.3 | 153.6 |
| 20-Dec | 13.3 | 12.8 | 45.4 | 44.3 | 124.5 | 125.8 | 139.4 | 138.2 |
| C.D. (P=0.05) | NS | NS | 4.2 | 3.9 | 8.3 | 7.1 | 13.1 | 14.1 |

NS=Non-significant

recorded at 12 days interval after sowing crop and have been presented in (Table 4).

A perusal of data for both the years under study indicated that leaf area index (LAI) did not vary significantly within varieties *viz*., HPW-249, HPW-42 and HPW-155 from 12 DAS to 60 DAS except during second year at 60 DAS. However, the highest LAI values were recorded in HPW-249 followed by HPW-155 and HPW-42 during both the years. The LAI values at 12 DAS varied between 0.141 and 0.144 and progressively increased slowly *i.e*. 0.605 to 0.642 upto 72 DAS, thereafter fast growth in leaves were observed which reflected in increased LAI after 84 DAS. The maximum LAI was observed at 120 to 132 DAS in all the varieties. The LAI started decreasing after 132 DAS in all the varieties. The maximum value of LAI was observed to the tune of 3.11 and 2.90 at 120 and 132 DAS, respectively, in variety HPW-249 followed by HPW-155 and HPW-42. Similar trends were observed from 12 DAS to 132 DAS. On 144 DAS, the significantly highest LAI was observed in HPW-249 in both the years of field experimentation which was followed by HPW-155 and HPW-42. Amongst the sowing windows from 20th October to 20th December, LAI values showed significant differences from 12 DAS to 144 DAS. The significantly lowest LAI was observed in 20th December sown crop and highest values was observed when sown on 20th October in all the periodic observations of LAI from 12 DAS to 144 DAS except 96 DAS. The maximum LAI was observed during 120 to 132 DAS and there after it decreased progressively upto 72 DAS. The LAI observed increasing with higher rate after 72 DAS. The significantly highest LAI values were observed to the tune of 3.21 and 3.30 during 2011-12 at 120 and 132 DAS during 2012-13 in 20th October sown crops. The LAI was not significantly varied between 20th October to 10th November, 10th November to 30th November sown crops but significantly lowest values were recorded in 20th December sown crop. At 156 DAS revealed that variety HPW-249 produced higher leaf area index both the years 1.27 in 2011-12 and 1.24 in 2012-13 followed by a HPW-155 and HPW-42. Amongst dates of sowing, 20th October sown crop produced LAI to the tune of 1.31 during 2011-12 and 1.37 in 2012-13 followed by 10th November, 30th November and 20th December in both the years.

The maximum leaf area index was observed in variety HPW-249 in both the years. Amongst dates of sowings, 20th October sown crop recorded significantly higher leaf area index. By virtue of optimum climatic conditions, October 20 sown crop plants attained more plant height and dry matter accumulation in wheat during both the years. These results are in conformity with the results reported by Sharma and Kumar (2005) under similar agro-climatic conditions. Leaf area index at harvest decreased due to increas- ed leaf aging and senescence, shading and competition between plants for light and other resources, especially, when wheat encounters high temperatures. Decrease in plant height and leaf-area index (LAI) in December sowings was due to reduction in duration of vegetative growth stage. This reduction might be due to lower temperature prevailed during earlier vegetative growth stage and high temperature hastened the leaf senescence and crop maturity in late sown crop. These results are in line with those reported by Ram *et*

**Table 2 : Effect of sowing dates and varieties on growth yield attributes and yield of wheat during 2011-12 and 2012-13**

| | Plant height (cm) | | Number of tillers $m^{-2}$ | | Number of grains $tiller^{-1}$ | | 1000 grain weight (g) | | Grain yield (q $ha^{-1}$) | | Straw yield (q $ha^{-1}$) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2011-12 | 2012-13 | 2011-12 | 2012-13 | 2011-12 | 2012-13 | 2011-12 | 2012-13 | 2011-12 | 2012-13 | 2011-12 | 2012-13 |
| **Variety** | | | | | | | | | | | | |
| HPW-155 | 97.1 | 98.2 | 280.3 | 283.3 | 47.1 | 47.2 | 44.2 | 45.4 | 38.7 | 41.3 | 55.4 | 61.9 |
| HPW-249 | 105.7 | 103.1 | 296.8 | 302.2 | 48.5 | 49.1 | 46.3 | 47.3 | 41.3 | 44.2 | 59.1 | 65.8 |
| HPW-42 | 99.4 | 100.1 | 263.2 | 268.2 | 45.1 | 45.1 | 43.1 | 43.4 | 37.6 | 39.8 | 52.2 | 59.1 |
| C.D. (P=0.05) | NS | NS | 12.8 | 16.2 | NS | NS | NS | NS | 2.2 | 1.8 | 2.9 | 3.1 |
| **Dates of sowing** | | | | | | | | | | | | |
| 20 Oct | 107.5 | 105.2 | 301.2 | 311.9 | 48.2 | 49.4 | 47.1 | 48.4 | 43.0 | 45.6 | 61.5 | 68.4 |
| 10 Nov | 102.9 | 103.8 | 296.1 | 298.1 | 47.3 | 47.5 | 46.1 | 47.3 | 41.5 | 44.4 | 59.3 | 66.0 |
| 30 Nov | 99.9 | 98.6 | 276.2 | 281.3 | 45.2 | 46.1 | 43.3 | 43.1 | 37.8 | 40.4 | 54.1 | 60.6 |
| 20 Dec | 96.5 | 94.2 | 247.1 | 251.3 | 43.3 | 45.3 | 41.9 | 42.6 | 34.5 | 36.6 | 47.9 | 54.1 |
| C.D. (P=0.05) | 5.2 | 6.3 | 13.4 | 17.2 | 2.1 | 3.2 | 2.7 | 2.9 | 2.5 | 2.1 | 3.4 | 3.6 |

NS=Non-significant

*al.* (2012).

**1000-grain weight (g) :**

A perusal of the data revealed that varieties did not differ statistically with each other in respect of 1000-grain weight during both the years. However, HPW-249 produced higher grain weight (46.3 g in 2011-12 and 47.3 g in 2012-13) followed by HPW-155 and HPW-42 during both the years. The 1000-grain weight varied significantly in sowing environments. The crop sown on 20th October produced significantly highest grain weight to the tune of 47.1 g during 2011-12 and 48.4 g during 2012-13 followed by 10th November 30th November and 20th December sown crop during both the years. This might be due to the early sowing and early vegetative growth and heading of crop and also because of optimum temperature during the different phases (Table 2). Decline in number of grains spike$^{-1}$ with successive delay in sowing was also reported by Singh and Kumar (2005). Similar findings were also reported by Singh *et al*. (2013). Mukherjee (2012) revealed from the study that the reduction in 1,000-grain weight due to delay in sowing was mainly attributed to reduction in growth and shrivelled grains because of forced maturity which occurred due to sudden temperature rise and westerly wind prevailed during milking and grain filling stage. Kaur *et al*. (2015) indicated heat stress during February under Punjab conditions as a major biotic constraint resulted in maximum reduction in number of grains/ear and 1000 grain weight.

**Grain yield (q ha$^{-1}$) :**

The data presented revealed that variety HPW-249 gave significantly highest grain yield (41.3 q ha$^{-1}$ in 2011-12 and 44.2 q ha$^{-1}$ in 2012-13) as compared to HPW-155 and HPW-42 during both the years. Amongst dates of sowing, 20th October sown crop significantly out yielded the subsequent dates of sowing (43.0 q ha$^{-1}$ during 2011-12 and 45.6 q ha$^{-1}$ during 2012-13) during both the years (Table 2). The highest grain yield on 20th October sown crop is due to higher 1000-grain weight, number grains per tiller and LAI which reflected in higher grain yield. Yield variations amongst various sowing dates is due to the variability of temperature change as shifting sowing time in 1 week of November offer opportunity for yield improvement by late sown crop adversely affected by exceptional high temperature for March and April, which coincided with thermo-sensitive grain-filling stage of wheat and led to forced crop maturity. Similar observations were also made by Pradhan *et al.* (2014). Talukder *et al*. (2014) also reported heat stress can cause wheat yield reduction upto 25% and the effect varies with the varieties. Early heading wheat genotypes with slower rate of leaf senescence after heat exposure and longer post-heading duration could be more tolerant to heat stress. Pandey *et al.* (2014) revealed form study conducted under north Bihar conditions that crop sown on 25th November sown crop recorded significantly higher grain yield (35.7 q/ha) than earlier as well as later sown crop and also observed significant variation among the varieties

**Straw yield (q ha$^{-1}$) :**

A perusal of data indicated significantly highest straw yield in variety HPW-249 to the tune of (59.1 q ha$^{-1}$ in 2011-12 and 65.8 q ha$^{-1}$ in 2012-13) followed by HPW-155 and HPW-42 during both the years. The sowing environments significantly influenced the straw yields

**Table 3 : Effect of sowing dates and varieties on gross returns, (Rs. ha$^{-1}$), net returns (Rs. ha$^{-1}$) and B: C ratio of wheat during 2011-12 and 2012-13**

| | Gross returns (Rs. ha$^{-1}$) | | Net returns (Rs. ha$^{-1}$) | | B:C ratio | |
|---|---|---|---|---|---|---|
| | 2011-12 | 2012-13 | 2011-12 | 2012-13 | 2011-12 | 2012-13 |
| **Variety** | | | | | | |
| HPW-155 | 70828 | 76426 | 42330 | 46888 | 1.4 | 1.5 |
| HPW-249 | 75568 | 81219 | 47070 | 51681 | 1.6 | 1.7 |
| HPW-42 | 67383 | 72943 | 38885 | 43405 | 1.3 | 1.4 |
| C.D. (P=0.05) | 3807 | 3849 | 3807 | 3849 | 0.133 | 0.130 |
| **Dates of sowing** | | | | | | |
| 20 Oct | 78708 | 84394 | 50210 | 54855 | 1.7 | 1.8 |
| 10 Nov | 75842 | 81496 | 47344 | 51958 | 1.6 | 1.7 |
| 30 Nov | 69197 | 74777 | 40699 | 45239 | 1.4 | 1.5 |
| 20 Dec | 61291 | 66783 | 32793 | 37245 | 1.1 | 1.2 |
| C.D. (P=0.05) | 4396 | 4445 | 4396 | 4445 | 0.154 | 0.150 |

during both the years. The early sown crop on 20th October gave significantly highest straw yield of 61.5 q $ha^{-1}$ during 2011-12 and 68.4 q $ha^{-1}$ during 2012-13 followed by 10th November, 30th November and 20th December sown crops (Table 2). The higher yields in early sown crop on October might be due to the reason that October 20 sown crop received optimum environmental conditions for crop growth and get more time for attaining different pheno-phases. Similar findings were also reported by Sharma and Kumar (2005) under similar agro climatic conditions of Palampur.

**Gross returns :**

The data revealed that significantly highest gross returns were obtained in variety HPW-249 to the tune of Rs. 75568 during 2011-12 and Rs. 81219 during 2012-13 as compared to HPW-155 (Rs.70828 in 2011-12 and Rs. 76426 in 2012-13) and HPW-42 (Rs. 67383 during 2011-12 and Rs. 72943 in 2012-13). Amongst sowing dates, 20th October sown crop gave significantly highest gross returns of Rs. 78708 during 2011-12 and Rs. 84394 during 2012-13 followed by 10th November, 30th November and 20th December during both the years (Table 3).

**Net returns :**

Likewise, for gross returns the data revealed that significantly highest net returns were accrued in variety HPW-249 as compared to HPW-155 and HPW-42 during both the years. Amongst sowing dates, October 20 sown crop gave significantly highest net returns to the tune of Rs. 50210 during 2011-12 and Rs. 54855 during 2012-13 followed by 10th November, 30th November and 20th December (Table 3).

**Table 4 : Effect of sowing dates and varieties on leaf area index during 2011-12 and 2012-13**

| | 12 DAS | | 24 DAS | | 36 DAS | | 48 DAS | | 60 DAS | | 72 DAS | | 84 DAS | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2011-12 | 2012-13 | 2011-12 | 2012-13 | 2011-12 | 2012-13 | 2011-12 | 2012-13 | 2011-12 | 2012-13 | 2011-12 | 2012-13 | 2011-12 | 2012-13 |
| **Variety** | | | | | | | | | | | | | | |
| HPW-155 | 0.144 | 0.136 | 0.152 | 0.253 | 0.253 | 0.283 | 0.460 | 0.369 | 0.488 | 0.485 | 0.642 | 0.662 | 0.949 | 1.080 |
| HPW-249 | 0.144 | 0.136 | 0.156 | 0.256 | 0.299 | 0.283 | 0.474 | 0.383 | 0.496 | 0.508 | 0.677 | 0.687 | 1.160 | 1.210 |
| HPW-42 | 0.141 | 0.130 | 0.150 | 0.253 | 0.247 | 0.276 | 0.431 | 0.364 | 0.481 | 0.468 | 0.605 | 0.623 | 0.893 | 0.943 |
| C.D. (P=0.05) | NS | NS | NS | NS | NS | NS | NS | NS | NS | 0.028 | 0.031 | 0.036 | 0.038 | 0.051 |
| **Dates of sowing** | | | | | | | | | | | | | | |
| 20 Oct | 0.155 | 0.148 | 0.158 | 0.284 | 0.268 | 0.294 | 0.531 | 0.390 | 0.506 | 0.514 | 0.674 | 0.672 | 1.180 | 1.310 |
| 10 Nov | 0.152 | 0.144 | 0.156 | 0.260 | 0.253 | 0.280 | 0.467 | 0.380 | 0.494 | 0.489 | 0.693 | 0.696 | 1.035 | 1.100 |
| 30 Nov | 0.142 | 0.125 | 0.152 | 0.240 | 0.252 | 0.260 | 0.416 | 0.359 | 0.492 | 0.479 | 0.632 | 0.654 | 0.934 | 0.977 |
| 20 Dec | 0.123 | 0.119 | 0.144 | 0.231 | 0.294 | 0.241 | 0.406 | 0.359 | 0.463 | 0.466 | 0.567 | 0.608 | 0.852 | 0.921 |
| C.D. (P=0.05) | 0.013 | 0.015 | 0.012 | 0.021 | 0.024 | 0.033 | 0.026 | 0.023 | 0.032 | 0.036 | 0.039 | 0.044 | 0.049 | 0.064 |

Table 4 contd…

| | 96 DAS | | 108 DAS | | 120 DAS | | 132 DAS | | 144 DAS | | 156 DAS | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2011-12 | 2012-13 | 2011-12 | 2012-13 | 2011-12 | 2012-13 | 2011-12 | 2012-13 | 2011-12 | 2012-13 | 2011-12 | 2012-13 |
| **Variety** | | | | | | | | | | | | |
| HPW-155 | 1.80 | 1.84 | 2.24 | 2.39 | 3.05 | 2.81 | 2.84 | 2.88 | 1.71 | 1.76 | 1.27 | 1.24 |
| HPW-249 | 1.81 | 1.84 | 2.34 | 2.44 | 3.11 | 2.89 | 2.90 | 2.96 | 1.80 | 1.90 | 1.27 | 1.24 |
| HPW-42 | 1.76 | 1.82 | 2.24 | 2.31 | 3.03 | 2.79 | 2.81 | 2.83 | 1.66 | 1.57 | 1.25 | 1.22 |
| C.D. (P=0.05) | NS | NS | NS | NS | NS | NS | NS | NS | 0.11 | 0.13 | | |
| **Dates of sowing** | | | | | | | | | | | | |
| 20-Oct | 1.84 | 1.87 | 2.46 | 2.51 | 3.21 | 3.00 | 3.30 | 3.35 | 2.28 | 2.17 | 1.31 | 1.37 |
| 10-Nov | 1.82 | 1.85 | 2.26 | 2.12 | 3.10 | 2.91 | 3.14 | 3.25 | 2.10 | 2.22 | 1.30 | 1.28 |
| 30-Nov | 1.78 | 1.84 | 2.23 | 2.34 | 3.02 | 2.81 | 2.84 | 2.98 | 1.99 | 1.87 | 1.23 | 1.25 |
| 20-Dec | 1.70 | 1.78 | 2.01 | 2.22 | 2.93 | 2.60 | 2.01 | 1.98 | 1.06 | 1.12 | | |
| | | | | | | | | | | (Before harvest) | | |
| C.D. (P=0.05) | NS | NS | 0.13 | 0.14 | 0.16 | 0.12 | 0.18 | 0.23 | 0.21 | 0.26 | | |

NS=Non-significant

**Benefit cost ratio :**

The data revealed that significantly highest benefit cost ratio in variety HPW-249 **(**Rs. 1.6 during 2011-12) and (Rs. 1.7 during 2012-13) as compared to HPW-155 and HPW-42. Amongst sowing dates, October 20 sown crop showed significantly highest benefit cost ratio of Rs. 1.7 in 2011-12 and Rs. 1.8 in 2012-13 followed by 10th November, 30th November and 20th December (Table 3).

The data on gross returns, net returns and B: C ratio revealed gradual reduction due to the delayed planting of crop from October 20 in both years. The highest gross returns, net returns and benefit cost ratio of Rs. 75568, 47070 and 1.6, respectively in the first year and Rs. 81219, 51681 and 1.7, respectively during second year were obtained from 20th October sown crop. Kumar (2011) also worked out the economics of the wheat crop under varying sowing environments and concluded higher net returns in early sown crop during October compared to December sown crop.

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