



## Effects of seeding methods and nutrient management practices on growth and yield of organic wheat (*Triticum aestivum*)

ADARSH SHARMA<sup>1\*</sup>, S K SHARMA<sup>2</sup>, ROSHAN CHOUDHARY<sup>3</sup>, GAJANAND JAT<sup>3</sup>,  
LATIKA VYAS<sup>1</sup> and SHARVAN KUMAR YADAV<sup>1</sup>

Maharana Pratap Univesity of Agriculture and Technology, Udaipur, Rajasthan 313 001, India

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### ABSTRACT

An experiment was conducted out during winter (*rabi*) seasons of 2021–22 and 2022–23 at the Research Farm of Maharana Pratap Univesity of Agriculture and Technology, Udaipur, Rajasthan to study the effect of nutrient management practices and sowing methods on the development and production of organic wheat (*Triticum aestivum* L.). The experiment was conducted in a split plot design (SPD) with 4 replications. The experiment consisted of 3 sowing methods in main plots, viz. Flat row sowing; FIRB (Furrow Irrigated Raised Bed) sowing; and zero tillage sowing and 8 nutrient management practices, viz. 100% RDN through FYM as basal; RDN through FYM as basal + 50% RDN with first irrigation; 75% RDN through FYM as basal + 25% RDN with first irrigation; 50% RDN through FYM as basal + 25% RDN with first irrigation + 25% RDN with second irrigation; 100% RDN through FYM as basal + *jeevamrit* @500 litre/ha at sowing and first irrigation + *panchagavya* @5% at booting stage; 50% RDN through FYM as basal + 50% RDN with first irrigation + *jeevamrit* @500 litre/ha at sowing and first irrigation + *panchagavya* @5% at booting stage; 75% RDN through FYM as basal + 25% RDN with first irrigation + *jeevamrit* @500 litre/ha at sowing and first irrigation + *panchagavya* @5% at booting stage; 50% RDN through FYM as basal + 25% RDN with first irrigation + 25% RDN with second irrigation + *jeevamrit* @500 litre/ha at sowing and first irrigation + *panchagavya* @5% at booting stage in sub plots. The experimental results revealed that the FIRB sowing method recorded significantly higher plant height at 45 DAS (42.56 and 42.66 cm) during both the years of study over zero tillage sowing method and remain at par with flat row sowing method, respectively. The same sowing method resulted into statistically higher grain yield (42.88 and 43.87 q/ha) and biological yield (106.89 and 108.48 q/ha) compared to flat row sowing and zero tillage sowing methods during both the years, respectively. During the second year of study (2023) significantly highest crop growth rate (CGR) (1.1240 g/m<sup>2</sup>/day) and relative growth rate (RGR) (0.0083 g/g/day) between 90 DAS to harvest were recorded with flat row sowing over zero tillage sowing and remain at par with FIRB sowing method. Regarding the nutrient management practices the highest plant height (43.43 and 44.51 cm), grain yield (44.52 and 44.84 q/ha) and biological yield (110.35 and 110.58 q/ha) were recorded with 75% RDN through FYM as basal + 25% RDN with first irrigation + *jeevamrit* @500 litre/ha at sowing and first irrigation + *panchagavya* @5% at booting stage.

**Keywords:** Biological yield, Crop growth rate, Grain yield, Nutrient management, Relative growth rate, Sowing method

Wheat (*Triticum aestivum* L.), a primary cereal crop in India and globally, is a key source of carbohydrates, protein, calories, and nutritional content in low- and middle-income countries. In India, wheat is grown in about 31.61 million hectares with production of 109.52 million tonnes and productivity of 3464 kg/ha in the *rabi* season of 2020–21 (MoA and FW 2021). Wheat's factor productivity is decreasing due to a broad NPK ratio, inadequate

micronutrient content, falling soil organic carbon, and uneven fertilizer application (Sharma and Sharma 2006).

The monocropping system led to deterioration in soil quality. If the current trend continues, the country will face a serious problem in utilization of scarce natural resources (Bhattacharyya *et al.* 2015). Organic farming is gaining popularity, with markets for organic foods rapidly expanding in several nations, including India (Sharma *et al.* 2021). Organic farming faces challenges due to the time-consuming process of altering soil's chemical, physical, and biological properties to achieve ecological equilibrium. Numerous studies have shown lower yields at first, which are followed by yields that are comparable to those of traditional production (Liebhardt *et al.* 1989).

<sup>1</sup>Maharana Pratap Univesity of Agriculture and Technology, Udaipur, Rajasthan; <sup>2</sup>ICAR-Indian Agricultural Research Institute, New Delhi; <sup>3</sup>Sri Karan Narendra Agriculture Univesity, Jobner, Jaipur, Rajasthan. \*Corresponding author email: [adarshdadhich77@gmail.com](mailto:adarshdadhich77@gmail.com)

Conventional tillage practices in cereal-based cropping systems, particularly the maize (*Zea mays*)-wheat cropping system, have a negative impact on the physical and chemical qualities of the soil overall in both conventional and organic systems (Mathew *et al.* 2012). Reduced yield as well as decreased productivity and soil fertility were the results of these changes. Methods of sowing constitute an important component of physical environment of soil and therefore, could affect the crop establishment, growth and yield of crops by its impact on plant rooting, soil nutrients and moisture extraction pattern (Mollah *et al.* 2009).

One of the key elements in increasing wheat output in organic farming is nutrient management. In organic wheat, the recommended dose of nitrogen is applied through FYM, compost, or other organic sources (Sharma *et al.* 2018). To improve wheat yield under organic farming, it's crucial to reduce the amount of manure applied and supplement it with other nutrient sources. This can be achieved by dividing dosage and adding organic liquid manures at different times. Hence, the present study was carried out to increase the production of organic wheat by different nutrient management practices and sowing methods.

## MATERIALS AND METHODS

Field experiment was conducted during winter (*rabi*) seasons of 2021–22 and 2022–23 at the Research Farm of Maharana Pratap University of Agriculture and Technology, Udaipur (24°35' N, 72°42' E and at an altitude of 581.13 m amsl), Rajasthan. The experimental site is situated at sub-humid southern plain and Aravalli hills. The experimental soil was clay loam with slightly alkaline reaction (pH 8.0 and 7.9), medium level of organic carbon (0.66 and 0.68%), medium available nitrogen (256.1 and 257.2 kg/ha) and phosphorus (25.51 and 25.88), and rich potassium (304.90 and 305.11 kg/ha). The experiment was conducted in split plot design (SPD) replicated four times with nutrient management practices as factor A, viz. 3 sowing methods in main plots, viz. Flat row sowing ( $S_1$ ); FIRB (Furrow Irrigated Raised Bed) sowing ( $S_2$ ); and zero tillage sowing ( $S_3$ ) and 8 nutrient management practices, viz. 100% RDN through FYM as basal ( $M_1$ ); 50% RDN through FYM as basal + 50% RDN with first irrigation ( $M_2$ ); 75% RDN through FYM as basal + 25% RDN with first irrigation ( $M_3$ ); 50% RDN through FYM as basal + 25% RDN with first irrigation + 25% RDN with second irrigation ( $M_4$ ); 100% RDN through FYM as basal + *jeevamrit* @500 litre/ha at sowing and first irrigation + *panchagavya* @5% at booting stage ( $M_5$ ); 50% RDN through FYM as basal + 50% RDN with first irrigation + *jeevamrit* @500 litre/ha at sowing and first irrigation + *panchagavya* @5% at booting stage ( $M_6$ ); 75% RDN through FYM as basal + 25% RDN with first irrigation + *jeevamrit* @500 litre/ha at sowing and first irrigation + *panchagavya* @5% at booting stage ( $M_7$ ); 50% RDN through FYM as basal + 25% RDN with first irrigation + 25% RDN with second irrigation + *jeevamrit* @500 litre/ha at sowing and first irrigation +

*panchagavya* @5% at booting stage ( $M_8$ ) in sub plots. The wheat variety Raj-4079 was sown on 16 November 2021 and 18 November 2022.

### Sowing methods

*Flat row sowing method:* The seeds were sown in opened furrows manually at a depth of 5 cm in rows spaced at 22.5 cm apart.

*Furrow irrigated raised bed:* The dimension of the beds was 90 cm wide (top of the bed) × 15 cm height × 30 cm furrow width (at top) and the spacing from centre of the furrow to another centre of the furrow was kept at 120 cm seeding was done in 5 rows at 18 cm spacing on the raised beds.

*Zero tillage sowing method:* The seeds were sown directly without any land preparations with the help of tractor drawn zero till ferti-seed drill.

*Nutrient management practices:* Organic farming techniques were carried out in accordance with the National Programme on Organic Production (Organic Farming Crop Production Guide).

*Application of FYM:* For organic production of wheat i.e. farmyard manure (FYM) was used to supply recommended dose of nitrogen. It was procured from Livestock Unit, Rajasthan College of Agriculture, Udaipur, Rajasthan and split application of FYM was applied according to the treatments.

*Preparation and application of jeevamrit:* A barrel was filled with 200 litres of water, 10 kg of fresh desi cow dung, and 10 litres of old cow urine. Two kg of jaggery, two kg of pulse flour (gram), and around 100 gm of living soil collected from beneath the banyan tree's canopy are added to this. Give the mixture a good stir, then let it to ferment in the shade for 48 h. *Jeevamrit* is now prepared for use (Palekar 2006). At the of sowing and 1<sup>st</sup> irrigation *jeevamrit* were applied @500 litre/ha.

*Preparation and application of panchagavya:* In an earthen container, first mix 5 kg fresh cow dung and 1 kg cow ghee thoroughly and keep it for 3 days. Mix it twice daily (morning/evening) at least for 15 minutes. Add 3 litre cow urine, 3 litre cow milk, 2 kg cow curd and also 500 gm jaggery and mix thoroughly. Keep it for 15 days with regular mixing in morning and evening hours. *Panchagavya* stock solution will be ready after proper sieving through a fine cloth.

Crop growth rate (CGR) is the represent of dry matter accumulation from a unit ground area per unit time. It was computed empirically as (Watson 1958):

$$CGR = \frac{1}{P} \times \frac{W_2 - W_1}{T_2 - T_1}$$

where  $W_1$ , Dry weight of the plants (g/m<sup>2</sup>) at time  $T_1$ ;  $W_2$ , Dry weight of the plants (g/m<sup>2</sup>) at time  $T_2$ ;  $T_1 - T_2$ , Time interval in days between 90 DAS to harvest; and P, Unit ground area in (m<sup>2</sup>).

Relative growth rate (RGR) is the rate of increase crop

growth per unit dry matter already present per unit of time. It is computed as (Radford 1967):

$$RGR = \frac{(\log W_2 - \log_e W_1)}{T_2 - T_1}$$

where  $\log_e$ , Natural log;  $W_1$ , Dry weight of plants (g) at time  $T_1$ ; and  $W_2$ , Dry weight of plants (g) at time  $T_2$ .

## RESULTS AND DISCUSSION

### Growth attributes

**Plant height at 45 DAS:** Sowing methods significantly influenced the plant height of wheat at 45 DAS during 2022 and 2023 of study as well as on pooled data basis (Table 1). The maximum plant height was recorded under treatment FIRB sowing method which was significantly superior over treatment zero tillage sowing method. But its effect was found at par with treatment  $S_1$  (flat row sowing) during both

the year of study. Data further revealed that on pooled basis, treatment  $S_2$  (FIRB) recorded a significant increase in plant height at 45 DAS by 3.74 and 7.22% over treatment  $S_1$  (flat row sowing) and  $S_3$  (zero tillage), respectively. Similarly, treatment  $S_1$  (flat row sowing) recorded a significant increase of 3.22% plant height at 45 DAS over treatment  $S_3$  (zero tillage). Among nutrient management practices application of RDN through FYM with and without *jeevamrit* and *panchagavya* significantly increased plant height of wheat at 45 DAS during 2022, 2023 and on the basis of pooled data. Application of treatment  $M_7$  (75% RDN through FYM as basal + 25% RDN with first irrigation with *jeevamrit* @500 litre/ha at sowing and first irrigation + *panchagavya* @5% at booting stage) recorded maximum plant height at 45 DAS which was significantly superior over all the other treatments. But during 2022, it was found at par with two treatment  $M_6$  and  $M_8$  and during 2023 it was found at par with treatment  $M_6$ . Data further revealed on pooled basis,

Table 1 Effect of sowing methods and nutrient management practices on plant height, crop growth rate and relative growth rate of organic wheat

| Treatment                                                                                                               | Plant height (cm) at 45 DAS |         |        | CGR (g/m <sup>2</sup> /day) at 90 DAS-At harvest |         |        | RGR (g/g/day) at 90 DAS-At harvest |         |        |
|-------------------------------------------------------------------------------------------------------------------------|-----------------------------|---------|--------|--------------------------------------------------|---------|--------|------------------------------------|---------|--------|
|                                                                                                                         | 2021–22                     | 2022–23 | Pooled | 2021–22                                          | 2022–23 | Pooled | 2021–22                            | 2022–23 | Pooled |
| <b>Sowing methods</b>                                                                                                   |                             |         |        |                                                  |         |        |                                    |         |        |
| $S_1$ , Flat row sowing                                                                                                 | 40.51                       | 41.52   | 41.02  | 1.1082                                           | 1.1240  | 1.1161 | 0.0083                             | 0.0083  | 0.0083 |
| $S_2$ , FIRB                                                                                                            | 42.56                       | 42.66   | 42.61  | 1.0847                                           | 1.0727  | 1.0787 | 0.0079                             | 0.0078  | 0.0079 |
| $S_3$ , Zero tillage                                                                                                    | 39.12                       | 40.37   | 39.74  | 1.0094                                           | 1.0094  | 1.0094 | 0.0077                             | 0.0077  | 0.0077 |
| SEm±                                                                                                                    | 0.51                        | 0.38    | 0.32   | 0.0296                                           | 0.0170  | 0.0171 | 0.0002                             | 0.0001  | 0.0001 |
| CD ( $P=0.05$ )                                                                                                         | 1.76                        | 1.33    | 0.98   | NS                                               | 0.0588  | 0.0525 | NS                                 | 0.0003  | 0.0003 |
| <b>Nutrient management practices</b>                                                                                    |                             |         |        |                                                  |         |        |                                    |         |        |
| $M_1$ , 100% RDN through FYM as basal                                                                                   | 38.08                       | 39.06   | 38.57  | 1.0486                                           | 1.0570  | 1.0528 | 0.0082                             | 0.0082  | 0.0082 |
| $M_2$ , 50% RDN through FYM as basal + 50% RDN with first irrigation                                                    | 39.35                       | 40.38   | 39.87  | 1.0547                                           | 1.0555  | 1.0551 | 0.0081                             | 0.0080  | 0.0080 |
| $M_3$ , 75% RDN through FYM as basal + 25% RDN with first irrigation                                                    | 40.29                       | 41.32   | 40.81  | 1.0591                                           | 1.0620  | 1.0605 | 0.0078                             | 0.0078  | 0.0078 |
| $M_4$ , 50% RDN through FYM as basal + 25% RDN with first irrigation + 25% RDN with second irrigation                   | 38.87                       | 39.91   | 39.39  | 1.0380                                           | 1.0411  | 1.0395 | 0.0079                             | 0.0080  | 0.0079 |
| $M_5$ , $M_1$ + <i>jeevamrit</i> @500 litre/ha at sowing and first irrigation + <i>panchagavya</i> @5% at booting stage | 41.01                       | 41.31   | 41.16  | 1.0667                                           | 1.0691  | 1.0679 | 0.0080                             | 0.0079  | 0.0080 |
| $M_6$ , $M_2$ + <i>jeevamrit</i> @500 litre/ha at sowing and first irrigation + <i>panchagavya</i> @5% at booting stage | 43.11                       | 43.31   | 43.21  | 1.0879                                           | 1.0910  | 1.0894 | 0.0079                             | 0.0078  | 0.0079 |
| $M_7$ , $M_3$ + <i>jeevamrit</i> @500 litre/ha at sowing and first irrigation + <i>panchagavya</i> @5% at booting stage | 43.43                       | 44.51   | 43.97  | 1.1071                                           | 1.0939  | 1.1005 | 0.0079                             | 0.0078  | 0.0079 |
| $M_8$ , $M_4$ + <i>jeevamrit</i> @500 litre/ha at sowing and first irrigation + <i>panchagavya</i> @5% at booting stage | 41.71                       | 42.32   | 42.01  | 1.0776                                           | 1.0800  | 1.0788 | 0.0079                             | 0.0079  | 0.0079 |
| SEm±                                                                                                                    | 0.64                        | 0.60    | 0.44   | 0.0609                                           | 0.0412  | 0.0368 | 0.0005                             | 0.0003  | 0.0003 |
| CD ( $P=0.05$ )                                                                                                         | 1.81                        | 1.70    | 1.23   | NS                                               | NS      | NS     | NS                                 | NS      | NS     |

DAS, Days after sowing; FIRB, Furrow irrigated raised bed; FYM, Farmyard manure; RDN, Recommended dose of nitrogen; CGR, Crop growth rate; RGR, Relative growth rate; NS, Non-significant.

split application of only RDN through FYM treatment  $M_3$  (75% RDN through FYM as basal + 25% RDN with first irrigation) recorded significantly higher plant height at 45 DAS (40.81 cm) by 5.80, 3.47% over the treatment  $M_1$  and  $M_4$ , respectively whereas, its effect was found at par with treatment  $M_2$  (50% RDN through FYM as basal + 50% RDN with first irrigation). Split application of RDN through FYM with *jeevamrit* and *panchagavya* treatment  $M_7$  (75% RDN through FYM as basal + 25% RDN with first irrigation with *jeevamrit* @500 litre/ha at sowing and first irrigation + *panchagavya* @5% at booting stage) registered significantly higher plant height at 45 DAS (43.97 cm) by 6.82 and 4.66% over the treatment  $M_5$  and  $M_8$ , respectively whereas, it was found statistically at par with treatment  $M_6$  (50% RDN through FYM as basal + 50% RDN with first irrigation + *jeevamrit* @500 litre/ha at sowing and first irrigation + *panchagavya* @5% at booting stage).

*CGR and RGR between 90 DAS to at harvest:* It is apparent from data presented in Table 1 revealed that effect of sowing methods significant influence on CGR and RGR between 90 DAS to at harvest. The maximum CGR and RGR between 90 DAS to at harvest were recorded under treatment  $S_1$  (flat row sowing) which was significantly higher over treatment  $S_3$  (zero tillage) sowing and FIRB sowing methods. However, in case of CGR, flat row sowing was found at par with treatment  $S_2$  (FIRB) during 2023. During experimentation year 2022 sowing methods had non-significant effect on CGR between 90 DAS to at harvest. Nutrient management practices were found to be non-significant effective in increase of CGR and RGR.

Experiment findings proves that FIRB sowing method recorded higher growth attributes may be due to suitable environment for vegetative growth of the crop. FIRB sowing method provided better environment for wheat growth

Table 2 Effect of sowing methods and nutrient management practices on number of effective tillers, grain yield and biological yield organic wheat

| Treatment                                                                                                               | Number of effective tillers/<br>plant at 75 DAS |         |        | Grain yield<br>(q/ha) |         |        | Biological yield<br>(q/ha) |         |        |
|-------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|---------|--------|-----------------------|---------|--------|----------------------------|---------|--------|
|                                                                                                                         | 2021–22                                         | 2022–23 | Pooled | 2021–22               | 2022–23 | Pooled | 2021–22                    | 2022–23 | Pooled |
| <b>Sowing methods</b>                                                                                                   |                                                 |         |        |                       |         |        |                            |         |        |
| $S_1$ , Flat row sowing                                                                                                 | 5.70                                            | 5.81    | 5.75   | 40.46                 | 41.58   | 41.02  | 101.52                     | 102.80  | 102.16 |
| $S_2$ , FIRB                                                                                                            | 5.73                                            | 5.90    | 5.82   | 42.88                 | 43.87   | 43.38  | 106.89                     | 108.48  | 107.68 |
| $S_3$ , Zero tillage                                                                                                    | 5.32                                            | 5.47    | 5.40   | 38.27                 | 39.40   | 38.84  | 96.31                      | 97.71   | 97.01  |
| SE $\pm$                                                                                                                | 0.07                                            | 0.06    | 0.05   | 0.59                  | 0.62    | 0.43   | 1.44                       | 1.51    | 1.04   |
| CD ( $P=0.05$ )                                                                                                         | 0.26                                            | 0.21    | 0.15   | 2.05                  | 2.13    | 1.32   | 4.98                       | 5.24    | 3.22   |
| <b>Nutrient management practices</b>                                                                                    |                                                 |         |        |                       |         |        |                            |         |        |
| $M_1$ , 100% RDN through FYM as basal                                                                                   | 5.14                                            | 5.41    | 5.28   | 37.54                 | 38.57   | 38.05  | 94.94                      | 96.09   | 95.52  |
| $M_2$ , 50% RDN through FYM as basal + 50% RDN with first irrigation                                                    | 5.56                                            | 5.61    | 5.58   | 39.18                 | 41.02   | 40.10  | 99.05                      | 102.00  | 100.52 |
| $M_3$ , 75% RDN through FYM as basal + 25% RDN with first irrigation                                                    | 5.66                                            | 5.72    | 5.69   | 39.73                 | 41.21   | 40.47  | 100.37                     | 102.33  | 101.35 |
| $M_4$ , 50% RDN through FYM as basal + 25% RDN with first irrigation + 25% RDN with second irrigation                   | 5.52                                            | 5.57    | 5.55   | 37.74                 | 39.41   | 38.57  | 95.59                      | 97.84   | 96.71  |
| $M_5$ , $M_1$ + <i>jeevamrit</i> @500 litre/ha at sowing and first irrigation + <i>panchagavya</i> @5% at booting stage | 5.37                                            | 5.75    | 5.56   | 40.56                 | 41.57   | 41.06  | 101.18                     | 102.39  | 101.78 |
| $M_6$ , $M_2$ + <i>jeevamrit</i> @500 litre/ha at sowing and first irrigation + <i>panchagavya</i> @5% at booting stage | 5.84                                            | 5.89    | 5.87   | 43.32                 | 43.83   | 43.57  | 107.46                     | 108.06  | 107.76 |
| $M_7$ , $M_3$ + <i>jeevamrit</i> @500 litre/ha at sowing and first irrigation + <i>panchagavya</i> @5% at booting stage | 5.97                                            | 6.02    | 6.00   | 44.52                 | 44.84   | 44.68  | 110.35                     | 110.58  | 110.46 |
| $M_8$ , $M_4$ + <i>jeevamrit</i> @500 litre/ha at sowing and first irrigation + <i>panchagavya</i> @5% at booting stage | 5.61                                            | 5.81    | 5.71   | 41.71                 | 42.49   | 42.10  | 103.62                     | 104.71  | 104.16 |
| SE $\pm$                                                                                                                | 0.11                                            | 0.08    | 0.07   | 0.71                  | 0.73    | 0.51   | 1.73                       | 1.80    | 1.25   |
| CD ( $P=0.05$ )                                                                                                         | 0.31                                            | 0.23    | 0.19   | 2.02                  | 2.05    | 1.42   | 4.90                       | 5.10    | 3.50   |

FIRB, Furrow irrigated raised bed; RDN, Recommended dose of nitrogen; FYM, Farmyard manure; DAS, Days after sowing.



and development, where water was used more efficiently, and caused an increase in photosynthetic potential (Wang *et al.* 2004). These findings are in accordance with the observations of Mollah *et al.* (2009) and Jat *et al.* (2011).

According to the current study, the significant impact of split nitrogen fertilisation through FYM with *jeevamrit* and *panchagavya* on crop growth appears to be caused by the plant system's ability to sustain a favourable nutritional environment because of their significantly higher nutrient availability from soil media. The findings of the current experimental study, which demonstrated that split nitrogen application 75% as basal and 25% at first irrigation with *jeevamrit* and *panchagavya* application at booting stage well demonstrate this. They also showed that this increased the content and uptake of macro and micronutrients. This may also be explained by the positive impact on enzyme and microbial activity. This may have led to an increase in meristematic tissue activity, which in turn promoted cell division and expansion. These results corroborate with the findings of Ramesh *et al.* (2015) and Siddappa *et al.* (2016).

#### Yield attributes and yield

**Number of effective tillers/plant at 75 DAS:** The effective tillers of wheat at 75 DAS are significantly impacted by the planting techniques used (Table 2). The greatest effective tillers were observed under treatment S<sub>2</sub> (FIRB), which was found to be comparable to treatment S<sub>1</sub> (flat row sowing) in both years, but much higher than treatment S<sub>3</sub> (zero tillage). The data also showed that, as compared to treatment S<sub>3</sub> (zero tillage), treatment S<sub>2</sub> (FIRB) significantly increased the number of effective tillers (5.82/plant) on a pooled basis by 7.77% whereas, it was found at par with treatment S<sub>1</sub> (flat row sowing). Compared to treatment S<sub>3</sub> (zero tillage), treatment S<sub>1</sub> (flat row sowing) had no discernible impact on the number of effective tillers. Amongst nutrient management practices on pooled data basis, split application of only RDN through FYM treatment M<sub>3</sub> (75% RDN through FYM as basal + 25% RDN with first irrigation) recorded significant increase effective tillers (5.69/plant) by 7.76% over the treatment M<sub>1</sub>. Whereas, its non-significant effect was found with treatment M<sub>2</sub> (50% RDN through FYM as basal + 50% RDN with first irrigation), M<sub>4</sub> (50% RDN through FYM as basal + 25% RDN with first irrigation + 25% RDN with second irrigation).

Split application of RDN through FYM with *jeevamrit* and *panchagavya* treatment M<sub>7</sub> (75% RDN through FYM as basal + 25% RDN with 1<sup>st</sup> irrigation with *jeevamrit* @500 litre/ha at sowing and 1<sup>st</sup> irrigation + *panchagavya* @5% at booting stage) registered significantly higher number of effective tillers (6.0/plant) by 7.91 and 5.07% over the treatment M<sub>5</sub> and M<sub>8</sub>, respectively. Whereas, it was found statistically at par with treatment M<sub>6</sub> (50% RDN through FYM as basal + 50% RDN with first irrigation + *jeevamrit* @500 litre/ha at sowing and first irrigation + *panchagavya* @5% at booting stage).

**Seed yield and biological yield:** FIRB sowing method

recorded a significant increase in grain yield (43.38 q/ha) and biological yield by 5.75 and 11.68% and biological yield (107.68 q/ha) by 5.40 and 10.99% over treatment flat row and zero tillage sowing methods, respectively (Table 2). Similarly, treatment S<sub>2</sub> (FIRB) recorded an increase of 5.61 and 5.30% grain yield and biological yield respectively, over the treatment S<sub>3</sub> (zero tillage). Amongst nutrient management practices, split application of RDN through only FYM a perusal of two year pooled data showed that the significantly maximum grain yield (40.47 q/ha) and biological yield (101.35 q/ha) were registered under M<sub>3</sub> (75% RDN through FYM as basal + 25% RDN with first irrigation) by 6.36, 4.92 and 5.75, 4.78% over the treatment M<sub>1</sub> (100 % RDN through FYM as basal) and M<sub>4</sub> (50% RDN through FYM as basal + 25% RDN with first irrigation + 25% RDN with second irrigation, respectively. However, it was found statistically at par with treatment M<sub>2</sub> (50% RDN through FYM as basal + 50% RDN with first irrigation). Split application of RDN through FYM with *jeevamrit* and *panchagavya*, treatment M<sub>7</sub> (75% RDN through FYM as basal + 25% RDN with 1<sup>st</sup> irrigation with *jeevamrit* @500 litre/ha at sowing and first irrigation + *panchagavya* @5% at booting stage) registered significantly higher grain yield (44.68 q/ha), biological yield (110.46 q/ha) by 8.81, 6.12 and 8.52, 5.49% over the treatment M<sub>5</sub> and M<sub>8</sub>, respectively. Whereas, its effect was found at par with treatment M<sub>6</sub> (50% RDN through FYM as basal + 50% RDN with first irrigation + *jeevamrit* @500 litre/ha at sowing and first irrigation + *panchagavya* @5% at booting stage).

Higher number of effective tillers, grain and biological yield recorded in FIRB planting can also be attributed to better soil environment in ridges since prolonged ponding reduces yield. FIRB sowing method may have improved the growing environment, soil structure, and availability of essential nutrients, which ultimately enhanced the economic yield of wheat. The findings of the present investigation are in conformity with those of Sepat *et al.* (2010) and Kaur and Dhaliwal (2015).

The increase in number of effective tillers, grain and biological yield of wheat due to split application of FYM with *jeevamrit* and *panchagavya* could be due to better availability of nutrients and plant growth hormones during the critical period of crop growth. Similar results were also observed by Shwetha (2008) who reported that 25–35% increase in seed yield of soybean with the application of *beejamrut*, *jeevamrit* and *panchagavya* along with different organic manures. Continuous mineralization and availability of nutrients as per the requirements during later stage of the plant growth might be the reason for higher values of yield attributes. The results are in close agreement with the findings of Yadav *et al.* (2017).

The current investigation's results support the hypothesis that the most effective way to increase the growth and productivity of organic wheat is to use the FIRB sowing method with application of 75% RDN through FYM as basal + 25% RDN with first irrigation + *jeevamrit* @500 litre/ha

at sowing and first irrigation + *panchagavya* application @5% at booting stage.

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