Impact of Different Seed Rates on Yield and Economics of Direct Seeded Rice in Eastern Vidharbha Zone of Maharashtra, India

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ABSTRACT

An experiment was conducted, for three consecutive years to evaluate the effect of seed rates on yield and economic traits in Bold as well as Fine seeded rice variety in terms of Direct-Seeded technique. The experiment was laid out in Factorial Randomized Block design and replicated thrice. Study concluded that Pooled means of seed rates at Sakoli indicated that sowing of 75 kg seed ha⁻¹ (3458 kg ha⁻¹) was expressively higher in grain yield but was at par with sowing of 50 kg seed ha⁻¹. As well as pooled mean at Sindewahi indicated that Variety Sye-2001 was higher in grain yield (3631 Kg ha⁻¹) of Rice than PKV HMT. The pooled mean of grain yield over three seasons and two locations revealed that variety Sye-2001 was significantly higher in grain yield over PKV HMT Variety. Among seed rates, 75 kg seed ha⁻¹ recorded significantly higher grain yield over other seed rates but was at par with 50 kg seed ha⁻¹. Interaction effect showed the variety Sye-2001 was significantly highest in grain yield at 75 kg seed ha⁻¹ and PKV HMT variety at 50 kg Seed ha⁻¹. Also the highest GMR, NMR and B:C ratio was recorded in Sye-2001 with 75 kg seed rate ha⁻¹ and in PKV HMT at 50 kg Seed ha⁻¹.

Keywords
Direct-seeded rice, Seed rate, GMR, NMR, Sye-2001, PKV-HMT

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Introduction

Seed rate has a great impact on plant density and the competitiveness of the crop stand, tiller, time to maturity and yield. Low plant density and improper sowing method are the most important factors of agronomic constraints for obtaining higher yields and have a positive influence on the yield of rice. Optimum plant density is the primary factor for obtaining higher yield in rice (Sivaesarajah et al., 1995). The increase in plant density increases total plant weight per unit area and decreases the total weight per plant (Yoyock et al., 1979). The number of plants per unit area has an impact on plant architecture, modifies growth and development pattern and effects on the production photosynthesis (Abuzar et al., 2011). The increase in plant density increases the yield up to a limit and thereafter a leveling off or decline in yield (Sivaesarajah et al., 1995). The reason for the reduction in yield is due to the reduction in resources per plant. So the reduction in yield
will not be compensated by increasing plant number. Direct seeding technique offers a useful option to reduce the limitations of transplanted rice. Direct seeding is being practiced in many developed countries where labour is scarce and expensive (Pingali et al., 1994). Direct-seeded rice occupies 26% of the total rice area in South Asia (Gupta et al., 2006). Direct seeding of rice avoids puddling, does not need continuous submergence, and thus reduces the overall water demand for rice culture. When rainfall at planting time is highly variable, direct seeding may help reduce the production risk (Singh et al., 2006). Direct seeding can also reduce the risk by avoiding terminal drought that lowers the yield of transplanted rice, especially if the latter is established late due to delayed rainfall. Direct seeding can facilitate crop intensification (Singh et al., 2008). In Vidharbha region of Maharashtra, rice is majorly grown by puddled transplanting method, which is laborious and costly method. The peak period of rice transplanting is in the month of July, which results in labour shortage at the time of transplanting. For this instance, the present study aimed to find out the suitable seed rate for bold and fine seeded rice under drill condition, effect of different seed rates on yield and yield attributing characters of drilled rice and the economics

Materials and Methods

The study was aimed to investigate the effect of different seed rates on yield and growth traits of bold and fine seeded rice varieties. Study conducted during three rainy (kharif) seasons of 2013-2016 at two locations Krishi Vigyan Kendra, Bhandara (Sakoli), Maharashtra, India and Zonal Agricultural Research Station, Sindewahi, Maharashtra, India. The experimental material comprised of two well-known rice varieties viz., Bold seeded: Sye-2001 (V1) and Fine seeded: PKV-HMT (V2) with five different seed rate combinations like Sowing of 50 kg seed ha⁻¹ (S1), 75 kg seed ha⁻¹ (S2), 100 kg seed ha⁻¹ (S3), 125 kg seed ha⁻¹ (S4) and 150 kg seed ha⁻¹ (S5). The experiment was planned in a Factorial Randomized Block Design and replicated thrice. The soil of experimental site was analyzed for initial soil nutrient status (Table 1) and the application of recommended dose of 125:62.5:62.5 kg NPK ha⁻¹ was common in all combinations. Date of Sowing and harvesting was strictly followed for consequent three years (Table 2).

Results and Discussion

Growth traits

Average results observed in growth traits as influenced by various seed rates on Bold and Fine seeded variety throughout three-year shows, as seed rate increases the plant height, grains panicle⁻¹, length of panicle and effective tillers sq. m⁻¹ decreases eventually (Table 3). In term of plant height V1 showed up 94.09 cm, was at its best among entire treatment combinations for three years followed by V1V2S3 attended 90.36 cm and V1V2S2 was at 89.30 cm. Number of tillers sq. m⁻¹ was recorded highest in V1 (531.73) but the fine seeded variety V2 showed 442.73 tillers sq. m⁻¹ (Table 3). Some different trends had been noticed like the number of tillers sq. m⁻¹ was increasing as seed rate increases in both varieties. Number of effective tillers sq. m⁻¹ was noticed superior at V1V2S3 (289.17) and V1V2S2 (285.33) in Bold as well as Fine seeded variety. Seed rate of 50 and 75 kg ha⁻¹ results the average panicle length of 20.95 cm and 20.25 cm but V1 showed the highest panicle length of 21.59 cm in consecutive three years average record (Table 3). The fine seeded variety V2 recorded the highest 179.09 grains panicle⁻¹ afterward V1V2S2 and V1V2S3 were at par to each other throughout the growing seasons. Miller et al., (1991) found that panicle is a key factor that determines and contributes 89% of differences in yield. These results are in line with those of Kenneth et al.,
(1996) who reported rough rice has gained high yield in the optimum plant stand. \( V_1V_2S_3 \) and \( V_1V_2S_2 \) showed the significantly highest grain yield sq. m\(^{-1}\) of 389.33 and 377.20 but in terms of variety \( V_1 \) results the high in grain yield. This is in agreement with the studies reported by Mahajan et al., (2004), Hardev et al., (2014) and Rajiv et al., (2013). Basically \( V_1 \) is Bold seeded variety so it has the high test weight of 25.72 g and \( V_2 \) was at 14.34 g. Similar results showing that yield of rice linearly increased with seed rate (density) has been reported by Baloch et al., (2002). The plants at low seed rate have sufficient space and this enables to utilize more nutrients, water and solar radiation for better photosynthesis. Hence, the individual plants performed better. This is in agreement with the studies reported by Baloch et al., (2002), Akbar et al., (2004), Prasad et al., (1999), IRRI (2008), Subbaiah et al., (2002), Gill et al., (2008), Sharma et al., (1992), Mahajan et al., (2006), Dongarwar et al., (2015) and Abou-Khalifa et al., (2014).

**Yield traits**

Pooled means of three consecutive years at ZARS Sindewahi location point to bold seeded variety \( V_1 \) - Sye-2001 for highest grain yield of 3631 Kg ha\(^{-1}\) than PKV HMT at 3167 kg ha\(^{-1}\). \( V_1V_2S_2 \) (75 kg ha\(^{-1}\) seed rate) was recorded significantly highest yield over other treatment with 3710 kg ha\(^{-1}\) of yield (Table 4). Interaction effects between variety and seed rate resulted as significant. \( V_1 \) - Sye-2001 recorded 4162 kg ha\(^{-1}\) grain yield, which was superior, over all other combinations, and \( V_2 \) - PKV HMT, recorded significantly higher yield, in seed rate \( S_1 \) - 50 kg seed ha\(^{-1}\) of 3710 kg ha\(^{-1}\) (Table 5). This is in agreement with the studies reported by Zhao et al., (2007), Chauhan et al., (2011), Gill et al., (2006), Phuong et al., (2005), Dongarwar et al., (2015) and Kaun et al., (2014). Pooled means of KVK, Bhandara (Sakoli) location for entire three years indicated that, variety \( V_1 \) - Sye-2001 was significantly higher, in grain yield of rice, with 3225 kg ha\(^{-1}\) of grain yield. Whereas \( V_2 \) - PKV HMT recorded grain yield of 2581 kg ha\(^{-1}\). Among various seed rates, \( V_1V_2S_2 \) (75 kg seed ha\(^{-1}\)) showed 3458 kg ha\(^{-1}\) of grain yield was higher but was at par with sowing of \( V_1V_2S_1 \) (50 kg seed ha\(^{-1}\)) with the yield of 3319 kg ha\(^{-1}\) (Table 6). The seed rate 50 kg and 75 kg ha\(^{-1}\) were at par with each other and significantly superior over other treatments. Pooled means of interaction of variety and seed rate at KVK, Bhandara (Sakoli) revealed that variety bold seeded \( V_1 \) - Sye-2001 was higher yield at \( S_2 \) (75 kg ha\(^{-1}\)) and fine seeded PKV HMT recorded best results at \( S_1 \) (50 kg ha\(^{-1}\)) seed rates (Table 7). Zhao et al., (2007), Chauhan et al., (2011), Gill et al., (2006), Phuong et al., (2005) and Kaun et al., (2014) also reported similar results. The results of pooled mean of grain yield over three seasons of both locations revealed that bold seeded \( V_1 \) - Sye-2001 variety recorded 3578 kg ha\(^{-1}\) of grain yield, which was expressively higher grain yield over fine seeded \( V_2 \) - PKV HMT Variety with 2874 kg ha\(^{-1}\) of yield.

Among different seed rates \( V_1V_2S_2 \) (75 kg seed ha\(^{-1}\)) recorded 3584 kg ha\(^{-1}\) of grain yield which was significantly higher grain yield, over other seed rates but was at par, with \( S_1 \) (50 kg seed ha\(^{-1}\)) which was with 3485 kg ha\(^{-1}\) of yield (Table 8). Interaction effect between variety and seed rate revealed that that \( V_1 \) Sye-2001 variety recorded 4167 kg ha\(^{-1}\) of grain yield, which was significantly higher grain yield at \( S_2 \) - 75 kg seed ha\(^{-1}\). \( V_2 \) PKV HMT variety recorded yield of 3483 kg ha\(^{-1}\) at \( S_1 \) (50 kg seed ha\(^{-1}\)) (Table 9). This is in agreement with the studies reported by Kumhar et al., (2016), Payman et al., (2008), Walia et al., (2009), Baloch et al., (2002), Akbar et al., (2004), Prasad et al., (1999), IRRI 2008, Subbaiah et al., (2002), Gill et al., (2008), Sharma et al., (1992), Mahajan et al., (2006) and Abou-Khalifa et al., (2014).
### Table 1: Initial soil fertility status of ZARS Sindewahi and KVK, Bhandara (Sakoli), Maharashtra, India

| Particulars           | Locations                  | Method used                                                   |
|-----------------------|----------------------------|---------------------------------------------------------------|
|                       | ZARS Sindewahi             |                                                               |
|                       | KVK, Sakoli                |                                                               |
| pH                    | 7.30                       | pH meter (Piper, 1966)                                         |
| EC (dsm⁻¹)            | 0.22                       | Conductivity meter (Jackson, 1967)                            |
| Organic Carbon (%)    | 0.48                       | Walkley and Black method (Jackson, 1967)                      |
| Available N kg/ha     | 221.00                     | Alkaline permanganate method (Subbiah & Asija, 1956)          |
| Available P2O5 kg/ha  | 30.2                       | Olsen’s method (Jackson, 1967)                                |
| Available K2O kg/ha   | 290.00                     | Neutral normal ammonium acetate method (Jackson, 1967)        |

### Table 2: Dates of sowing and harvesting at ZARS Sindewahi and KVK, Bhandara (Sakoli), Maharashtra, India

| Parameter          | Date of Sowing | Date of Harvesting |
|--------------------|----------------|--------------------|
|                    | Sindewahi      | Sakoli             | Sindewahi | Sakoli           |
| First Year         | 01.07.2013     | 08.07.2013         | 08.11.2013| 15.11.2013       |
| Second Year        | 01.07.2014     | 08.07.2014         | 28.11.2014| 11.11.2014       |
| Third Year         | 01.07.2015     | 08.07.2015         | 10.11.2015| 20.11.2015       |

### Table 3: Average Ancillary Characters as influenced by different seed rates at ZARS Sindewahi and KVK, Bhandara (Sakoli), Maharashtra, India

| Treatments | Plant Height (cm) | No. of tillers sq. m⁻¹ | No. of effective tillers sq. m⁻¹ | Length of panicle (cm) | No. of grains per panicle | Grain yield sq.m⁻¹ (g) | Test weight (g) |
|------------|-------------------|------------------------|----------------------------------|------------------------|--------------------------|------------------------|-----------------|
| V₁         | 91.09             | 531.73                 | 275.33                           | 21.59                  | 114.12                   | 371.20                 | 25.72           |
| V₂         | 84.92             | 442.44                 | 236.26                           | 19.57                  | 179.09                   | 303.46                 | 14.34           |
| V₁V₂S₁     | 86.20             | 461.67                 | 232.67                           | 20.25                  | 137.43                   | 288.33                 | 20.13           |
| V₁V₂S₂     | 89.30             | 481.50                 | 285.33                           | 20.95                  | 156.53                   | 377.00                 | 19.96           |
| V₁V₂S₃     | 90.36             | 469.50                 | 289.17                           | 21.10                  | 159.25                   | 389.33                 | 20.17           |
| V₁V₂S₄     | 88.25             | 512.33                 | 253.50                           | 20.63                  | 148.65                   | 351.50                 | 20.19           |
| V₁V₂S₅     | 85.92             | 520.44                 | 218.33                           | 19.98                  | 131.15                   | 280.50                 | 19.72           |
### Table 4: Pooled Mean of grain yield of Rice (Kg ha\(^{-1}\)) as influenced by various treatments at Sindewahi, Maharashtra, India

| Treatment | Grain yield kg ha\(^{-1}\) 2013-14 | 2014-15 | 2015-16 | Pooled mean |
|-----------|----------------------------------|---------|---------|-------------|
| **Main plot : Varieties** |                                   |         |         |             |
| V\(_1\)   | 3441                             | 3427    | 4023    | 3631        |
| V\(_2\)   | 3298                             | 2781    | 3422    | 3167        |
| **SE\(\text{Em}\)±** | 110                             | 91.0    | 49      | 39          |
| **CD @ 5%** | NS                             | 554     | 298     | 236         |
| **CV %** | 12.62                           | 11.36   | 8.10    | 6.42        |
| **Sub Plot Seed rates** |                                   |         |         |             |
| V\(_1\)/V\(_2\)/S\(_1\) | 3578                             | 3245    | 3968    | 3597        |
| V\(_1\)/V\(_2\)/S\(_2\) | 3612                             | 3392    | 4125    | 3710        |
| V\(_1\)/V\(_2\)/S\(_3\) | 3448                             | 3099    | 3697    | 3415        |
| V\(_1\)/V\(_2\)/S\(_4\) | 3217                             | 2991    | 3545    | 3251        |
| **SE\(\text{Em}\)±** | 114                             | 98      | 119     | 78          |
| **CD @ 5%** | 341                            | 295     | 356     | 233.0       |
| **CV %** | 8.26                            | 7.75    | 7.80    | 5.60        |
| **Interaction between Variety x Seed Rate** |                                   |         |         |             |
| **SE\(\text{Em}\)±** | 161                             | 139     | 168     | 110         |
| **CD @ 5%** | NS                             | 433     | 522     | 342         |
| **CV %** | 8.26                            | 7.75    | 7.80    | 5.60        |

### Table 5: Pooled Interaction effect of Grain yield as influenced by different seed rates at Sindewahi, Maharashtra, India

| Treatments | S\(_1\) | S\(_2\) | S\(_3\) | S\(_4\) | S\(_5\) | Mean |
|------------|---------|---------|---------|---------|---------|------|
| V\(_1\)   | 3484    | 4162    | 3697    | 3514    | 3296    | 3631 |
| V\(_2\)   | 3710    | 3257    | 3132    | 2988    | 2750    | 3167 |
| **Mean**  | 3597    | 3710    | 3415    | 3251    | 3023    |      |
| **SE\(\text{Em}\)±** |                                   |         |         | 110     |
| **CD @ 5%** | NS     |         | 433     | 522     | 342     |
| **CV %** | 8.26    | 7.75    | 7.80    | 5.60    |

### Table 6: Pooled Mean of grain yield of Rice (Kg ha\(^{-1}\)) as influenced by various treatments at Sakoli, Maharashtra, India

| Treatment | Grain yield kg ha\(^{-1}\) 2013-14 | 2014-15 | 2015-16 | Pooled mean |
|-----------|----------------------------------|---------|---------|-------------|
| **Main plot : Varieties** |                                   |         |         |             |
| V\(_1\)   | 3424                             | 3275    | 3878    | 3225        |
| V\(_2\)   | 2436                             | 2471    | 2835    | 2581        |
| **SE\(\text{Em}\)±** | 118                             | 52      | 61      | 44          |
| **CD @ 5%** | 720                            | 317     | 370     | 266         |
| **CV %** | 15.63                            | 7.02    | 7.01    | 5.55        |
| **Sub Plot Seed rates** |                                   |         |         |             |
| V\(_1\)/V\(_2\)/S\(_1\) | 3079                             | 3226    | 3652    | 3319        |
| V\(_1\)/V\(_2\)/S\(_2\) | 3322                             | 3265    | 3788    | 3458        |
| V\(_1\)/V\(_2\)/S\(_3\) | 2872                             | 2810    | 3276    | 2986        |
| V\(_1\)/V\(_2\)/S\(_4\) | 2710                             | 2594    | 3183    | 2829        |
| V\(_1\)/V\(_2\)/S\(_5\) | 2667                             | 2471    | 2884    | 2674        |
| **SE\(\text{Em}\)±** | 128                             | 139     | 126     | 74          |
| **CD @ 5%** | 383                            | 416     | 379     | 222         |
| **CV %** | 10.67                            | 11.82   | 9.22    | 5.95        |
| **Interaction between Variety x Seed Rate** |                                   |         |         |             |
| **SE\(\text{Em}\)±** | 181                             | 196     | 179     | 105         |
| **CD @ 5%** | 562                            | 610     | 556     | 327         |
| **CV %** | 10.67                            | 11.82   | 9.22    | 5.95        |
### Table 7: Pooled Interaction effect of Grain yield as influenced by different seed rates at Sakoli, Maharashtra, India

| Treatments | S₁ | S₂ | S₃ | S₄ | S₅ | Mean |
|------------|----|----|----|----|----|------|
| V₁         | 3383 | 4172 | 3515 | 3360 | 3197 | 3525 |
| V₂         | 3255 | 2744 | 2456 | 2299 | 2151 | 2581 |
| Mean       | 3319 | 3458 | 2986 | 2829 | 2674 |

|                | SEm± | CD @ 5% | CV % |
|----------------|------|---------|------|
|                | 105  | 327     | 5.95 |

### Table 8: Pooled mean of grain yield (Kg ha⁻¹) as influenced by different treatments at ZARS Sindewahi and KVK, Bhandara (Sakoli), Maharashtra, India

| Treatment | Grain yield (Kg ha⁻¹) | Sindewahi | Sakoli | Pooled mean (Kg ha⁻¹) |
|-----------|----------------------|-----------|--------|-----------------------|
| Main plot: Varieties |                       |           |        |                       |
| V₁        | 3631                 | 3225      | 3578   |
| V₂        | 3167                 | 2581      | 2874   |
| SEm±      | 39                   | 44        | 30     |
| CD @ 5%   | 236                  | 266       | 183    |
| CV %      | 4.42                 | 5.55      | 3.61   |
| Sub Plot: Seed rates |                   |           |        |                       |
| V₁V₂S₁    | 3597                 | 3319      | 3458   |
| V₁V₂S₂    | 3710                 | 3458      | 3584   |
| V₁V₂S₃    | 3415                 | 2986      | 3200   |
| V₁V₂S₄    | 3251                 | 2829      | 3040   |
| V₁V₂S₅    | 3023                 | 2674      | 2848   |
| SEm±      | 78                   | 74        | 53     |
| CD @ 5%   | 233.0                | 222       | 159    |
| CV %      | 5.60                 | 5.95      | 4.02   |

### Interaction between Variety x Seed Rate

|                | SEm± | CD @ 5% | CV % |
|----------------|------|---------|------|
|                | 110  | 105     | 75   |
|                | 342  | 327     | 233  |
| CV %           | 5.60 | 5.95    | 4.02 |

### Table 9: Pooled Interaction effect of Grain yield as influenced by different seed rates at ZARS Sindewahi and KVK, Bhandara (Sakoli), Maharashtra, India

| Treatments | S₁ | S₂ | S₃ | S₄ | S₅ | Mean |
|------------|----|----|----|----|----|------|
| V₁         | 3434 | 4167 | 3606 | 3437 | 3246 | 3578 |
| V₂         | 3483 | 3001 | 2794 | 2644 | 2450 | 2874 |
| Mean       | 3458 | 3584 | 3200 | 3040 | 2848 |

|                | F Test | Sig. | SEm± | CD @ 5% | CV % |
|----------------|--------|------|------|---------|------|
|                |        | 75   |      | 233     | 4.02 |
### Table.10 Average Cost of cultivation, GMR, NMR and B:C ratio as influenced by different treatments at ZARS Sindewahi and KVK, Bhandara (Sakoli), Maharashtra, India

| Treatment | Pooled Grain yield (Q/ha) | Cost of cultivation | Gross Monetary Return (Rs/ha) | Net Monetary Return(Rs/ha) | B:C ratio |
|-----------|---------------------------|---------------------|-------------------------------|----------------------------|-----------|
| **Main plot : Varieties** | | | | | |
| V₁ | 3578 | 33500 | 50092 | 18047 | 1.49 |
| V₂ | 2874 | 34000 | 51736 | 18714 | 1.52 |
| F Test | Sig | Sig | NS | | |
| SEm± | 30 | 355 | 493 | | |
| CD @ 5% | 183 | 2159 | 3001 | | |
| CV % | 3.61 | 2.70 | 10.39 | | |
| **Sub Plot: Seed rates** | | | | | |
| V₁S₁ | 3458 | 32375 | 55380 | 24271 | 1.71 |
| V₁S₂ | 3584 | 33062 | 56175 | 24506 | 1.69 |
| V₁S₃ | 3200 | 33750 | 50391 | 17850 | 1.49 |
| V₁S₄ | 3040 | 34348 | 47849 | 14568 | 1.38 |
| V₁S₅ | 2848 | 35125 | 44776 | 10760 | 1.27 |
| F Test | Sig | Sig | Sig | | |
| SEm± | 53 | 890 | 1080 | | |
| CD @ 5% | 159 | 2667 | 3239 | | |
| CV % | 4.02 | 4.28 | 14.40 | | |
| **Interaction between Variety x Seed Rate** | | | | | |
| F Test | Sig. | Sig | Sig | | |
| SEm± | 75 | 1258 | 1528 | | |
| CD @ 5% | 233 | 3916 | 4756 | | |
| CV % | 4.02 | 4.28 | 14.40 | | |

### Table.11 Interaction effect on GMR as influenced by different seed rates at ZARS Sindewahi and KVK, Bhandara (Sakoli), Maharashtra, India

| Treatments | S₁ | S₂ | S₃ | S₄ | S₅ | Mean |
|------------|----|----|----|----|----|------|
| V₁         | 48074 | 58341 | 50487 | 48114 | 45451 | 50093 |
| V₂         | 62688 | 54011 | 50296 | 47856 | 44103 | 51737 |
| Mean       | 55381 | 56176 | 50392 | 47850 | 44777 | | |
| SEm±       | 1258 | | | | | |
| CD @ 5%    | 3916 | | | | | |
| CV %       | 4.28 | | | | | |

### Table.12 Interaction effect on NMR as influenced by different seed rates at ZARS Sindewahi and KVK, Bhandara (Sakoli), Maharashtra, India

| Treatments | S₁ | S₂ | S₃ | S₄ | S₅ | Mean |
|------------|----|----|----|----|----|------|
| V₁         | 17277 | 27067 | 18558 | 15246 | 12085 | 18047 |
| V₂         | 31264 | 21946 | 17143 | 13889 | 9330 | 18714 |
| Mean       | 24271 | 24506 | 17850 | 14568 | 10707 | | |
| SEm±       | 1528 | | | | | |
| CD @ 5%    | 4756 | | | | | |
| CV %       | 14.40 | | | | | |
Table 13 Treatment wise Cost of cultivation (INR ha\(^{-1}\)) at ZARS Sindewahi and KVK, Bhandara (Sakoli), Maharashtra, India

| Treatments | Cost of cultivation (INR ha\(^{-1}\)) |
|------------|--------------------------------------|
| V\(_1\)S\(_1\) | 32250.00 |
| V\(_1\)S\(_2\) | 32875.00 |
| V\(_1\)S\(_3\) | 33500.00 |
| V\(_1\)S\(_4\) | 34125.00 |
| V\(_1\)S\(_5\) | 34750.00 |
| V\(_2\)S\(_1\) | 32500.00 |
| V\(_2\)S\(_2\) | 33250.00 |
| V\(_2\)S\(_3\) | 34000.00 |
| V\(_2\)S\(_4\) | 34750.00 |
| V\(_2\)S\(_5\) | 35500.00 |

Economics traits

Labour saving of Direct Seeded Rice reduces 11.2% of total production cost as well as Direct Seeded Rice methods have several advantages over transplanting (Singh et al., 2005; Naresh et al., 2010). In addition to higher economic returns, Direct Seeded Rice crops are faster and easier to plant and less labor intensive (Jehangir et al., 2005). Thus, it is necessary to change the cultivation system from transplanting to direct seeded rice (Sanjitha Rani and Jayakiran, 2010).

In terms of Gross monetary return, V\(_1\)V\(_2\)S\(_2\) recorded the highest GMR with 56175 INR ha\(^{-1}\), in the same combination Net monetary return was also noticed higher with 24506 INR ha\(^{-1}\) with the B:C Ratio of 1.69 (Table 10). Whereas other combinations were not up to the mark for recommendations. The interaction effect of both locations for GMR, NMR and B: C stated that V\(_1\) was best with 58341 INR ha\(^{-1}\), 27067 INR ha\(^{-1}\) of GMR and NMR respectively only when it is transplanted with the seed rate of S\(_2\) - 75 kg ha\(^{-1}\) (Table 11). Effect on fine seeded variety V\(_2\)-PKV HMT was high in V\(_2\)S\(_1\) combination, which was reported 62688 INR ha\(^{-1}\), 31264 INR ha\(^{-1}\) of GMR and NMR respectively (Table 12). This is in agreement with the studies reported by Huang et al., (2013), Mehala et al., (2016), Singh et al., (2005), Rao et al., (2007), Naresh et al., (2010), Jagagir et al., (2005), Younas et al., (2016), Awan et al., (2005), Kahloon et al., (2012) and Mazher et al., (2017). The cost of cultivation of entire combinations has shown the normal phenomenal results of cultivars as the seed rate increases the cost of cultivations also increases (Table 13). These results were in accordance to Kumar et al., (2011) reported that labor saving of 86% and cost saving of 87% in Direct Seeded Rice compared to manual transplanting.

In paddy, a labor saving of 95-99% in Direct Seeded Rice was recorded compared to transplanting during three years. Sehrawat et al., (2010) also observed 13-16% labor saving in Direct Seeded Rice as compared to manual puddled transplanted rice. Kumar (2011) also recorded similar findings and found higher B: C ratio in Direct Seeded Rice as compared to transplanted rice. To get the highest grain yield, Gross monetary returns and net monetary returns from drilled rice in Eastern Vidarbha Zone of Maharashtra, 75 kg seed ha\(^{-1}\) for course varieties and 50 kg seed rate ha\(^{-1}\) for fine varieties with application of 125: 62.5: 62.5 kg NPK ha\(^{-1}\) is recommended. This is in agreement with the studies reported by
Husaain et al., (2013), Awan et al., (2005), Kumar et al., (2011), Iqbal et al., (2015), Seharawat et al., (2010), Gangawar et al., (2008) and Sidhu et al., (2014).

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