P-ISSN: 2618-0723
E-ISSN: 2618-0731

NAAS Rating: 5.04
www.extensionjournal.com

International Journal of Agriculture Extension and Social Development

Volume 7; Issue 10; October 2024; Page No. 396-400

Received: 08-08-2024
Accepted: 11-09-2024

Indexed Journal
Peer Reviewed Journal

Effect of seed treatments and foliar spray on dry matter production and yield of DSR rice

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DOI: https://doi.org/10.33545/26180723.2024.v7.i10f.1247

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Abstract

A field experiment was conducted at the Agricultural Research Station (ARS), Gangavathi to investigate the effect of seed treatment and foliar spray on growth and yield of dry DSR Rice during *kharif* 2021-22 and 2022-23. The experiment was laid out in split plot design with three replications. There were five seed treatments as main plot treatments and five foliar spray as sub-plot treatments. Among seed treatments, the pooled results indicated that, significantly higher dry matter production (63.07 g hill^{-1}), seed yield (66.93 q ha^{-1}) and straw yield (77.75 q ha^{-1}) was recorded in seed treatment with bio NPK @ 10 per cent. Whereas, significantly lower dry matter production (54.27 g hill^{-1}), seed yield (58.87 q ha^{-1}) and straw yield (67.40 q ha^{-1}) was recorded in control. Among the foliar spray, significantly higher dry matter production (64.12 g hill^{-1}), seed yield (67.85 q ha^{-1}) and straw yield (77.75 q ha^{-1}) was recorded with Jeevamrutha @ 3% during panicle initiation stage. However, it was on par with panchagavya @ 3% foliar spray during panicle initiation stage. Whereas, significantly lower seed yield (58.56 q ha^{-1}) and straw yield (67.40 q ha^{-1}) was noticed in control. Similar trends were observed in both the years of study.

Keywords: Foliar spray, Bio-NPK, Jeevamrutha, yield, rice

Introduction

Rice (*Oryza sativa* L.) is the world's largest food crop, supplying half of the world's population. It meets 27% of your daily calorie needs and 20% of your daily protein requirements. Rice production in India accounts for 20-25% of agricultural output and provides food for more than half of the population (Adhikary *et al*., 2022) [1]. In India, rice occupies an area of 45.0 million hectare with a production of 125.0 million tonnes with an average productivity of 2659 kg per hectare which is almost half of the global average. In Karnataka, rice is grown on an area of 1.39 m ha with an annual production of 4.32 m t and a productivity of 3089 kg ha^{-1} (Anon., 2023) [3].

Direct Seeded Rice offers a number of benefits over transplanted puddled rice systems. It saves water since it eliminates the need for nursery growing, puddling, and transplanting of seedlings. Thus, DSR reduces the labour requirement to the extent of about 40 per cent and water saving up to 60 per cent from nursery raising, field preparation, seepage, percolation and evaporation losses (Singh *et al.*, 2018) [17]. It offers certain advantages *viz.*, less labour, less water requirement, less drudgery, early crop maturity (07-10 days), low production cost, proper placement of seed and fertilizer, increase fertilizer use efficiency, improve soil health for crops and less greenhouse gas emission, in different cropping systems (Kaur and Singh, 2017) [12].

A good crop output in the field depends on uniform plant establishment and rapid early growth, both of which are hindered by various abiotic conditions like dryness. Under unfavourable environmental circumstances, seed priming which involves soaking seeds in water for a predetermined period of time before surface drying them may be able to promote quicker germination, improved establishment, and an increase in crop production (Mousavi *et al*., 2012) [13]. Importance of Bio NPK as a seed treatment for nitrogen (N_2) fixing (*Azotobacter* sp.), P-solubilizing (*Paenibacillus* sp.) and K-solubilizing (*Bacillus* sp.) bacteria improve nitrogen uptake, produce plant growth hormones and vitamins. These help the crop in better germination, early emergence and better root development and also increase the availability of micronutrients to plant from the soil resulting in faster root growth, nutrients uptake and increase resistance/tolerance towards diseases/drought.

The liquid organic manures easily disperse in water and are readily available to plants as compared to bulk organic manures and interestingly plants can absorb nutrients through the leaves about 20 times faster when applied as foliar spray than applied through the soil, thereby helps to overcome temporary and acute nutrient shortages in the crops (Dhanoji *et al.*, 2018) [10]. The jeevamrutha, beejamrutha, panchagavya, vermiwash and enriched biodigester liquid manure are easily available eco-friendly liquid organic manures which contains macro nutrients, essential micro-nutrients, amino acids, vitamins, growth promoting substances like IAA, GA and beneficial microorganisms improves higher productivity (Chongre *et al.*, 2019) [8]. Therefore in order to find out the effectiveness of seed treatment and foliar spray on dry matter production and yield of DSR rice, a field experiment was carried out at the Agricultural Research Station (ARS), Gangavathi

Materials and Methods

A field experiment was carried out at the Agricultural Research Station (ARS), Gangavathi. Soil is having medium black soil and experiment was laid out in split plot design having three replications and twenty-five treatment combinations for first experiment. I Factor: Seed treatments *such as.,* S_1: Control, S_2: Seed soaking in 1% $CaCl_2$ for 12 hrs, S_3: Seed soaking in 3% panchagavya for 12 hrs, S_4: Seed treatment with seed guard @ 2ml/kg seed and S_5: Seed treatment with bio NPK@10%. II Factor: Foliar spray *such as.,* F_1: Control, F_2: Nano urea foliar spray @ 2 ml/l during 25 DAS + @ 2.5 ml/l during 45 DAS, F_3: Panchagavya @ 3% foliar spray during panicle initiation stage, F_4: Jeevamrutha @ 3% foliar spray during panicle initiation stage and F_5: Rootam bio @ 1.5 g/l foliar spray during 2-4 leaf stage + stimula @ 1.5 ml/l during flowering and after flowering. Fertilizers were applied in the form of Urea, Diammonium phosphate (DAP) and Muriate of potash (MOP) for supplying nitrogen, phosphorus and potassium at the rate of 150:75:75 N, P_2O_5 and K_2O kg ha^{-1}. 50 per cent nitrogen was applied at the time of sowing, 25 per cent nitrogen was applied at tillering and remaining 25 percent at panicle initiation stage. Foliar application of different liquid organic manures were sprayed at different growth stages as per the treatments. During foliar application 750 liters spray mixture per hectare was used. The variety RNR 15048 used for this study and observation on dry matter production and yield data were collected and analyzed as per treatments.

Results and Discussion

Dry matter production

The graphical representation of dry matter production at 90 DAS and at harvest are presented in Figure 1. Among the seed treatments, at 90 DAS, seed treatment with 10% bio NPK produced significantly higher dry matter production (17.17 g/hill and 16.15 g/hill, respectively) in 2021 and 2022. However, it was comparable to seed soaking in panchagavya at 3% for 12 hours (17.06 g/hill and 15.66 g/hill, respectively) and seed treatment with seed guard at 2 ml/kg (16.97 g/hill and 15.50 g/hill, respectively) in 2021 and 2022. In comparison, the control group produced much less dry matter (15.57 and 13.74 g/hill, respectively) in 2021 and 2022. Similarly, pooled data revealed that seed treatment with bio NPK @ 10% resulted in significantly greater dry matter production (16.66 g per hill). However, it was in line with seed soaking in panchagavya @ 3% for 12 Hrs(16.36 g/hill) and seed treatment with seed guard @ 2 ml/ kg (16.24 g/hill). Whereas, significantly lower dry matter production (14.65 g/hill) was noticed in control.

Using jeevamrutha @ 3% foliar spray during panicle initiation stage resulted with significantly higher dry matter production at 90 DAS in 2021 and 2022 (17.30 g/hill and 16.39 g/hill, respectively). However, it was comparable to panchagavya @ 3% foliar spray (17.23 g/hill and 16.02 g/hill, respectively) and Nano urea foliar spray (16.93 g/hill and 15.48 g/hill, respectively) in 2021 and 2022. In contrast, the control group produced much less dry matter in 2021 and 2022 (15.41 and 13.22 g/hill, respectively). A parallel trend was noticed in the pooled data, where jeevamrutha @ 3% foliar spray resulted in significantly higher dry matter production (16.84 g/hill) than the control. However, it was found to be on par with panchagavya @ 3% (16.63 g/hill) foliar spray and nano urea foliar spray (16.21 g/hill). Whereas, significantly lower dry matter production (14.31 g/hill) was recorded in control.

At harvest, seed treatment with bio NPK @ 10% yielded in significantly higher dry matter production in 2021 and 2022 (64.93 g/hill and 61.21 g/hill, respectively). However, it was comparable to seed soaking in panchagavya at 3% for 12 hours (63.93 g/hill and 60.17 g/hill, respectively) and seed treatment with seed guard at 2 ml/kg (62.07 g/hill and 58.26 g/hill, respectively) in 2021 and 2022. The control group produced much less dry matter in 2021 and 2022 (56.89 and 52.86 g/hill, respectively). Similarly, aggregated studies showed that seed treatment with bio NPK @ 10% produced significantly higher dry matter (63.07 g/hill). However, it was comparable to seed soaking in panchagavya at 3% for 12 hours (62.05 g per hill). Whereas, significantly lesser dry matter production (54.27 g /hill) was recorded in control.

Using jeevamrutha at 3% foliar spray during panicle initiation stage resulted in significantly higher dry matter production (65.57 g/hill and 62.68 g/hill, respectively) at harvest in 2021 and 2022. However, it was comparable to panchagavya @ 3% foliar spray (64.81 and 60.38 g/hill, respectively). In contrast, throughout 2021 and 2022, the control group produced much less dry matter (56.80 and 52.33 g/hill). Similarly, pooled data showed that using jeevamrutha @ 3% foliar spray during panicle initiation resulted with significantly higher dry matter production (64.12 g/hill). However, it was on par with panchagavya @ 3% foliar spray (62.60 g/hill). In comparison, the control group produced much less dry matter (54.12 g/hill).

The interaction effect of several seed treatments and foliar spray at 90 DAS and harvest revealed no significant change in dry matter output. Among the treatment combinations in pooled data, S_5F_4 had numerically higher values for plant dry matter production per hill at 90 DAS (17.66 g) and at harvesting stage (68.60 g), whereas S_1F_1 had lower values for plant dry matter production per hill (12.58 g & 51.68 g, respectively) at 90 DAS and at harvesting stage.

Seed treatment with bio NPK and panchagavya treatments leads to higher dry matter accumulation due to improved nitrogen uptake, plant growth hormones, and vitamins. These treatments also increase micronutrient availability, resulting in faster root growth and increased resistance to diseases/drought. Bio NPK fertilizers also aid in uptake of other elements, enhancing photosynthesis (Anon., 2022) [2]. Microbial inoculants in seed treatments directly introduce microorganisms to the plant rhizosphere, a potent zone of microbial activity. This zone relies on nutrients, growth hormones, and antagonistic substances, with beneficial rhizosphere colonizing species increasing plant growth (Babalola, 2010 and Philippot *et al*., 2013) [4, 16].

The experiment found that higher growth parameters in plants with bio NPK were due to microbes that convert unavailable nutrients into easily available forms. The liquid biofertilizer consortium, including *Azopirillum lipoferum*, *Bacillus megaterium*, and *Frateuria aurantia*, promotes cell formation, division, elongation, and root development. This leads to better absorption and utilization of nutrients from soil, resulting in better overall plant growth. The microbes also produce growth-promoting substances, regulate pathogens, and promote beneficial organisms in the rhizosphere. The results are in accord with the research

findings of Deepti *et al.* (2022) [9] in Finger millet and Thakare *et al*. (2024) [18] in Sorghum.

The application of jeevamrutha significantly improved dry matter production in rice due to better availability of nutrients and plant growth hormones during critical crop growth periods. Panchagavya also containing plant growth substances, and results in rapid plant phenotype changes, promoting better crop growth and productivity. These findings are in accordance with Kasbe *et al.* (2015) [11] in rice, Narayanan *et al.* (2017) [14] in rice and Bhadu *et al.* (2021) [5] in wheat.

Seed yield

The graphical representation of seed yield, straw yield and Harvest Index are presented in Figure 2. The pooled results indicated that, significantly higher seed yield (66.93 q ha^{-1}) and straw yield (77.75 q ha^{-1}) were recorded in seed treatment with bio NPK @ 10 per cent. However, it was on par with seed soaking in panchagavya @ 3% for 12 hrs. Whereas, significantly lower seed yield (58.87 q ha^{-1}) and straw yield (67.40 q ha^{-1}) were recorded in control (Figure 2). The present investigation, reported that, higher seed yield in seed treatment with bio NPK @ 10 per cent which might be due to bio NPK comprising nitrogen (N_2) fixing (*Azotobacter* sp.), P-solubilizing (*Paenibacillus* sp.) and K-solubilizing (*Bacillus* sp.) bacteria improve nitrogen uptake, produce plant growth hormones and vitamins. These help the crop in better germination, early emergence and better root development and also increase the availability of micronutrients to plant from the soil resulting in faster root growth, nutrients uptake and increase resistance/tolerance towards diseases/drought. Further bio NPK fertilizers solubilizing potassium from insoluble forms by producing organic acids help in uptakes of other elements like nitrogen, phosphorus, and calcium *etc.*, resulted in increased vigour, photosynthatic accumulation and better translocation of photosynthates to the sink which ultimately resulted in higher yield. Bio-NPK is saving of chemical fertilizers up to 25-30 kg of Nitrogen, 10-15 kg of Phosphorus and 2–5 kg Potassium with increase in grain yield in crops like rice, wheat and maize.

Among the foliar spray, significantly higher seed yield (67.85 q ha^{-1}) and straw yield (79.33 q ha^{-1}) were recorded with jeevamrutha @ 3% during panicle initiation stage However, it was on par with panchagavya @ 3% foliar spray during panicle initiation stage. Whereas, significantly lower grain yield (58.56 q ha^{-1}) and straw yield (66.31 q ha^{-1}) were noticed in control. The similar trends were noticed during both the years. Higher grain yield was observed with jeevamrutha @ 3% foliar spray during panicle initiation stage might be due to nutrients that have been soluble in the soil and accumulated have made them available to plants all through their growth cycle, leading to an increase in growth attributes due to jeevamrutha application (Chaithra and Sujith, 2021) [7]. Further, foliar spray of panchagavya might have enhanced microbial activity on the plant parts like on leaves, shoot and fruits and also contains macronutrients like N, P and K essential micronutrients, many vitamins, essential amino acids, growth promoting factors like IAA, GA, which may provide nutrition to rhizosphere microorganisms. This inturn has a positive effect on growth and yield of crops. The similar results were reported by Boraiah *et al.*, 2017 [6]. The positive effect of panchagavya on growth and productivity of crops has been reviewed and documented by Boraiah *et al.* (2017) [6] in capsicum, Narayanan *et al.* (2017) [14] in rice, Patel *et al.* (2021) [15] in pearl millet and Kumar *et al.* (2021) in rice.

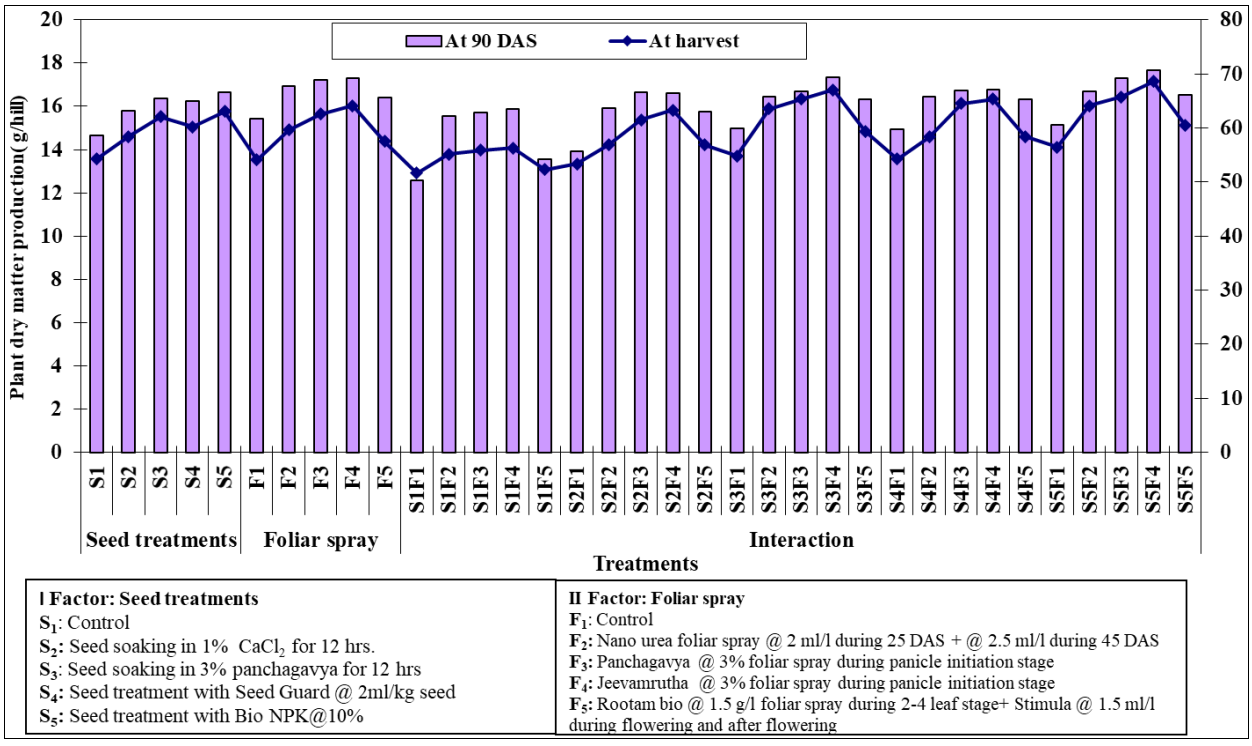

Fig 1: Plant dry matter production of paddy at different growth stages as influenced by different seed treatments and foliar spray

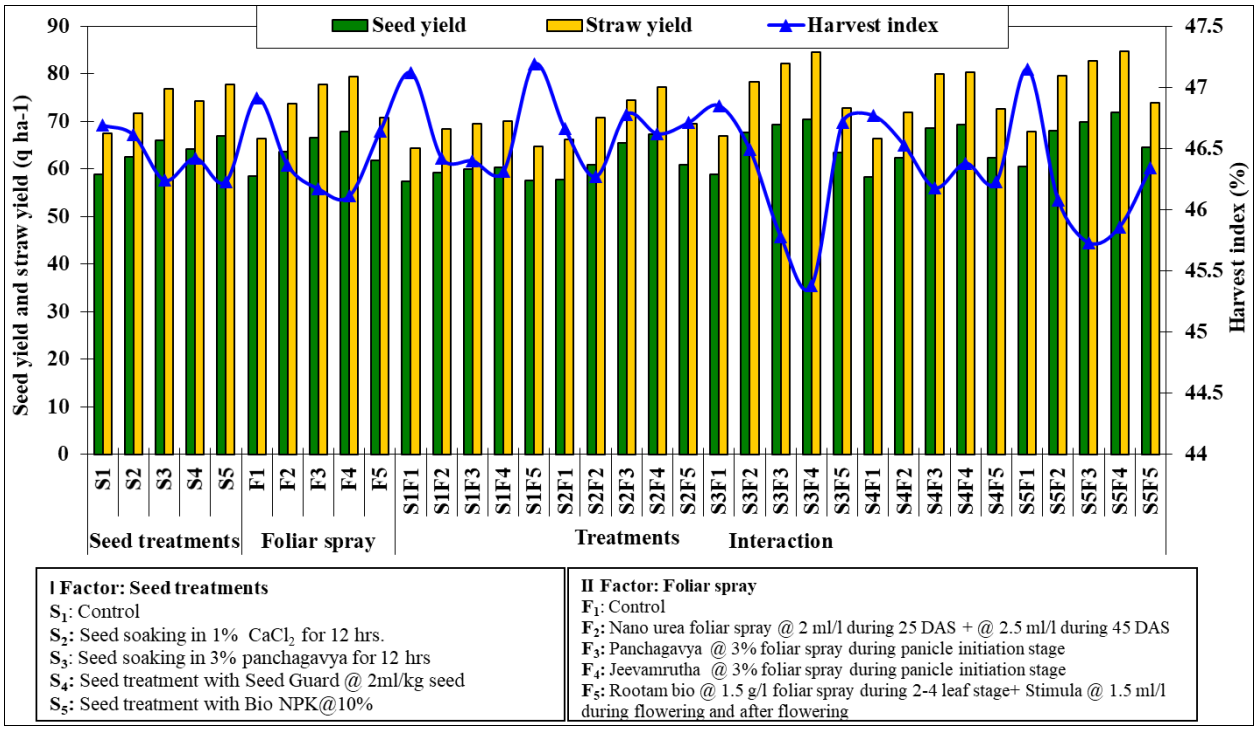

Fig 2: Seed and straw yield of paddy as influenced by different seed treatments and foliar spray

Conclusion

Among the seed treatments, seed treatment with bio NPK @ 10 per cent was found beneficial for getting higher growth and yield and which was on par with seed soaking in panchagavya @ 3% for 12 hrs have been found increasing the growth and yield of rice. Among the foliar spray, jeevamrutha @ 3% during panicle initiation stage recorded higher growth and yield of rice and which was on par with panchagavya @ 3% foliar spray during panicle initiation stage. Therefore, jeevamrutha @ 3% or panchagavya @ 3% foliar spray during panicle initiation stage can be taken up to realise improvement in growth and yield of rice.

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