International Journal of Economic Plants

https://ojs.pphouse.org/index.php/IJEP

Crossref

IJEP August 2024, 11(3): 228-232

Article IJEP5281a

Full Research

Doi: HTTPS://DOI.ORG/10.23910/2/2024.5281a

# Residue Retention and Potassium Nitrate Improvise the Yield and Economics of Wheat Crop

**Manpreet Jaidka* and Amandeep Singh Brar**

Krishi Vigyan Kendra, Budh Singh Wala, Moga, Punjab (142 002), India

**Corresponding Author**

Manpreet Jaidka
*e-mail*: mjaidka@pau.edu

**Article History**

Received on 05th March, 2024
Received in revised form on 05th June, 2024
Accepted in final form on 18th June, 2024

**Abstract**

The experiment was conducted during *rabi* (October, 2021-April, 2022) season at farmers' field in the NICRA adopted village Meenia, District Moga, Punjab to check the integrated effect of crop residue management practices and $KNO_3$ spray on the productivity of wheat crop. The trial was replicated four times with eight treatments viz., conventional sowing by residue burning, conventional sowing by residue burning *fb* foliar spray of $KNO_3$ (2%) at heading and anthesis stage, sowing of wheat with happy seeder, sowing of wheat with happy seeder *fb* foliar spray of $KNO_3$ (2%) at heading and anthesis stage, sowing of wheat with surface seeding, sowing of wheat with surface seeding *fb* foliar spray of $KNO_3$ (2%) at heading and anthesis stage, sowing of wheat after incorporation of paddy straw, sowing of wheat after incorporation of paddy straw *fb* foliar spray of $KNO_3$ (2%) at heading and anthesis stage. Results showed that surface seeding *fb* $KNO_3$ spray, happy seeder technology *fb* $KNO_3$ spray recorded significantly higher 1000 grain weight than conventional tillage. Surface seeding and $KNO_3$ spray recorded highest grain yield (4.91 t $ha^{-1}$) followed by happy seeder and $KNO_3$ spray (4.84 t $ha^{-1}$). A synergistic effect between CRM technologies and foliar application of $KNO_3$ was recorded where they resulted in 16.65 (4.84 t $ha^{-1}$), 18.34 (4.91 t $ha^{-1}$) and 5.38% higher grain yield in comparison to conventional sowing (4.15 t $ha^{-1}$). A highly significant positive correlation (r=0.449) was recorded between number of grains $ear^{-1}$ and grain yield. Surface seeding and happy seeder technology significantly increased net returns and B:C of wheat crop than conventional practices.

***Keywords:*** B:C, correlation, $KNO_3$, surface seeding, synergistic effect

## 1. Introduction

The Indo-Gangetic plains, covering about 10.5 mha, represent India's bread basket. In the prevailing rice-wheat cropping system in north western India, a large share out of the 2.5 million farmers burn an estimated 23 million metric tons of rice stubble in October and November to prepare their fields for the subsequent wheat crop (Anonymous, 2017). In addition to this, recurrent aberrant weather conditions pose a threat to sustainable food production across the globe. Among biotic and abiotic factors, heat stress is a significant factor affecting the wheat growth and yield (Karla et al., 2023). National Innovations in Climate Resilient Agriculture (NICRA) project provides platform to demonstrate proven technologies at the farmer's field in various Agro Climatic Zones (ACZ) and Agro-Ecological Situations (AES) (Lenka et al., 2023). As a result, farmers are considerably adopting climate-resilient agro-technologies along with income-generating activities for higher profit and sustainable development (Medhi et al., 2018). Stable and high yielding varieties under different environmental conditions would be the most important step in any breeding program before release as a variety (Gadisa et al., 2020). Climate change has an impact on agriculture, livestock, forestry, weather trends and patterns, rainfall and energy security (Hussain et al., 2020). Weather extremities have not only threatened food security but also added to the woes of the farming community along with loss of farm outputs. For instance, hike in temperature above 32°C at anthesis, leads to shorter grains, and decrease in grain filling duration which ultimately affects the wheat yield. Climate smart agriculture include water, energy, nutrient, weather oriented suitable practices for various crops and cropping systems. Technological intervention for climate smart agriculture is an integral part for modern day agriculture (Barua et al., 2023). Climate smart agriculture (CSA) includes technologies like happy seeder, surface seeding, $KNO_3$ spray etc. that certainly prove fruitful in developing climate resilient agriculture (CRA) (Jaidka et al., 2024). Agricultural and rural development strategies are now-a-days solely driven by climate resilience of any system (Taylor and Bhasme, 2021). The climate resilient agro-technologies (CRA) can prove propitious in modifying the present scenario for sustaining agricultural production (Lenka et al., 2022). The happy seeder can sow wheat crop in standing stubbles of preceding rice crop by leaving residue on the soil surface which acts as mulch and helps in soil moisture conservation, soil temperature regulation (Sidhu et al., 2015; Singh et al., 2015). The use of the happy seeder can reduce labour requirements up to 80%, irrigation requirement up to 20% (Saunders et al., 2012) and improve productivity, especially during harsh weather conditions (Aryal et al., 2016; Anonymous, 2012; Sidhu et al., 2015). The highest energy efficiency was recorded in happy seeder technology, which used 19.97 l of diesel to sow one-hectare area in comparison to 69.77 and 71.60 l in disc harrow-roto drill and disc harrows-broadcasting-rotavator techniques, respectively (Jaidka et al., 2020). Surface seeding technique, an eco-friendly method, has the potential to improve crop productivity on a sustainable basis. Compared to existing crop establishment methods, it has certain benefits with respect to crop productivity, environment, and socio-economic issues (Singh et al., 2022). Promoting surface seeding based management practices along with improved seeds, integrated soil and crop management is the key to sustainable production system (Gathala et al., 2020). Two foliar sprays of potassium nitrate @ 0.5% at boot and anthesis stage resulted in higher grain yield followed by one foliar spray @ 1.0% at anthesis stage of wheat in contrast to farmers' practice (no foliar spray) (Singh and Singh, 2020). Keeping in view the betterness of these techniques, the experiment was conducted in NICRA village to study the integrated effect of crop residue management technologies and foliar spray of potassium nitrate on productivity of wheat crop.

## 2. Materials and Methods

The experiment was conducted during *rabi* (October,2021–April, 2022) season at farmers' fields in the NICRA adopted village to study the effect of crop residue management practices with and without foliar application of potassium nitrate on the productivity of wheat crop. The trial consisted of eight treatments viz., $T_1$- Conventional sowing by residue burning, $T_2$- Conventional sowing by residue burning *fb* two foliar sprays of potassium nitrate @ 2% at heading and anthesis stage, $T_3$- Sowing of wheat with happy seeder (no potassium nitrate), $T_4$- Sowing of wheat with happy seeder *fb* two foliar sprays of potassium nitrate @ 2% at heading and anthesis stage, $T_5$- sowing of wheat with surface seeding (no potassium nitrate), $T_6$- sowing of wheat with surface seeding *fb* two foliar sprays of potassium nitrate @ 2% at heading and anthesis stage, $T_7$- Sowing of wheat after incorporation of paddy straw (no potassium nitrate), $T_8$- Sowing of wheat after incorporation of paddy straw *fb* two foliar sprays of potassium nitrate @ 2% at heading and anthesis stage. Each treatment was conducted on an area of 0.5 acre. The weather data showed an increased maximum temperature and less rainfall during 2022 than 2021 especially during the month of March and April. In March, 2022 maximum temperature was 30.3°C but it was 29.7°C in 2021. Similarly in April, 2022, the maximum temperature was 39.5°C but in 2021 it was 34.9°C. The total rainfall received in March 2021 and 2022 was 11.0 and 0.5 mm, respectively. Similarly, the total rainfall received in April 2021 and 2022 was 8.5 and 2.5 mm, respectively. The trial was replicated at four locations in the same village and all the data for various parameters was expressed as an average of those locations for data analysis. Sowing of wheat variety PBW 766 in all the treatments was done in first fortnight of November. All other crop management practices were followed as per the recommendations of Punjab Agricultural University, Ludhiana (Anonymous, 2023). The data pertaining to plant height and ear length were collected by measuring the height of 10 plants and ears, respectively, per treatment which was expressed as an average in cm. Data on number of ears was calculated by randomly throwing tetrad at 5 locations per treatment and expressed as an average value. Number of grains ear$^{-1}$ was expressed as an average value by counting grains in 10 randomly selected ear heads per treatment. 1000-grain weight was calculated 10 times per treatment to express as an average value. The data on grain yield was taken by harvesting the crop from an area of 0.25 acre by nullifying the border effect and was expressed as t ha$^{-1}$. Statistical analysis of the data was performed by using the statistical software OPSTAT. Benefit cost ratio was calculated by determining the gross returns and total cost of cultivation of wheat crop.

## 3. Results and Discussion

### 3.1. *Grain yield and yield attributes*

Data on plant height of wheat showed a non-significant difference among the treatments (Table 1). Similarly, an increase in ear length could not achieve level of significance in surface seeding and happy seeder technology relative to conventional tillage. Data on number of ears (Table 1) revealed that the highest number of ears was recorded in surface seeding treatments (464.79 and 467.33 in $T_5$ and $T_6$, respectively) which was statistically at par with conventional tillage and residue incorporation but significantly higher than happy seeder technology. The increase in number of ears in surface seeding can be attributed to better crop germination, better tillering due to favourable soil moisture regime and less mortality of tillers due to heat stress faced during heading stage due to alleviation of harmful effect of heat stress by potassium nitrate. Data pertaining to number of grains per ear depicted that surface seeding of wheat *fb* foliar spray of potassium nitrate recorded highest number of grains ear$^{-1}$ (46.85) followed by happy seeder *fb* foliar spray of potassium nitrate i.e., 46.67 which was statistically at par with surface seeding and happy seeder techniques alone. Furthermore, foliar application of potassium nitrate showed an enhancement effect on number of grains per ear in all the treatments irrespective of methodology used for management of paddy straw. Surface seeding *fb* foliar spray of potassium

Table 1: Effect of residue retention and potassium nitrate on grain yield, yield attributes and B:C of wheat crop

| Treatment | Plant height (cm) | Ear length (cm) | Ear ($m^{-2}$) (Numbers) | Grains $ear^{-1}$ (Nos.) | 1000 grain wt (g) | Grain yield ($t\ ha^{-1}$) | B:C |
|---|---|---|---|---|---|---|---|
| $T_1$ | 101.14 | 9.78 | 461.39 | 44.17 | 41.19 | 4.15 | 2.74 |
| $T_2$ | 101.16 | 9.80 | 464.27 | 45.00 | 41.61 | 4.23 | 2.74 |
| $T_3$ | 100.30 | 10.10 | 458.43 | 46.33 | 45.03 | 4.79 | 3.35 |
| $T_4$ | 101.44 | 10.16 | 461.36 | 46.67 | 45.54 | 4.84 | 3.36 |
| $T_5$ | 100.16 | 10.20 | 464.79 | 46.53 | 45.23 | 4.81 | 3.45 |
| $T_6$ | 100.36 | 10.23 | 467.33 | 46.85 | 45.79 | 4.91 | 3.46 |
| $T_7$ | 101.30 | 10.06 | 461.28 | 45.07 | 41.64 | 4.26 | 2.69 |
| $T_8$ | 100.46 | 10.10 | 463.71 | 45.29 | 42.07 | 4.37 | 2.71 |
| SEm± | | 0.25 | 5.95 | 2.19 | 2.20 | 1.71 | 0.15 |
| LSD ($p<0.05$) | NS | NS | 3.37 | 0.88 | 0.74 | 0.38 | 0.45 |

nitrate showed an increase by 0.69% as compared to sole surface seeding treatment ($T_5$). The increase in number of grains $ear^{-1}$ can be due to increase in ear length, better seed setting, and better alleviation of heat stress imparted by potassium nitrate. Interestingly, the data showed a peculiar effect of residue retention and foliar application of potassium nitrate on the 1000 grain weight of wheat. Surface seeding *fb* foliar spray of potassium nitrate, happy seeder technology *fb* foliar spray of potassium nitrate recorded significantly higher 1000 grain weight in comparison to conventional tillage and residue incorporation. Increase in 1000 grain weight due to residue retention alone as well as in combination with potassium nitrate can be due to favourable soil moisture and temperature regulation during heat stress, which in turn resulted in, better nutrient availability, longer period of grain filling, and better grain filling due to efficient translocation of assimilates towards the sink. Straw retention and foliar spray of potassium nitrate significantly increased the grain yield of wheat as compared to conventional tillage. Surface seeding *fb* foliar spray of potassium nitrate recorded highest grain yield (4.91 t $ha^{-1}$) followed by happy seeder *fb* foliar spray of potassium nitrate (4.84 t $ha^{-1}$). Increase in grain yield in residue retention and potassium nitrate can be attributed to favourable soil moisture regime and better temperature regulation, more number of grains $ear^{-1}$, consistently high 1000 grain weight even in the scenario of hike in ambient temperature. The results of increase in wheat yield by foliar spray of potassium nitrate are in line with Vijayakumar et al. (2019) who reported increased fertility percentage by 5 and grain yield of wheat by 6%. The data on the economics of wheat crop indicate show better B:C in happy seeder and surface seeding technology in contrast to conventional practice. Surface seeding *fb* foliar spray of potassium nitrate recorded highest B:C (3.46), which was statistically at par with $T_3$, $T_4$ and $T_5$ treatments but significantly different from rest of the treatments including conventional cultivation as well as incorporation of paddy straw. The improvisation in B:C in happy seeder and surface seeding technique with and without foliar spray of potassium nitrate can be attributed to decrease in cost of cultivation, increase in grain yield and net returns. Kadam et al. (2023) also reported 65.53% saving in cost of operation by sowing of wheat crop with happy seeder technique relative to conventional practice.

### 3.2. *Effect of residue retention and potassium nitrate*

The conservation practices recorded an increase in grain yield of wheat (Table 2). Cultivation of wheat crop with happy seeder, surface seeding and incorporation of paddy straw reported 15.57 (4.79 t $ha^{-1}$), 15.98 (4.81 t $ha^{-1}$) and 2.63% (4.26 t $ha^{-1}$) higher grain yield in contrast to conventional sowing (4.15 t $ha^{-1}$), respectively. Analysis of data depicted an increase in grain yield of wheat by foliar application of potassium nitrate irrespective of the conservation practices followed, although a range of variation was there among the practices. For instance, in conventional and surface seeding practices, potassium nitrate resulted in 1.88% (4.23 t $ha^{-1}$) and 2.36% (4.91 t $ha^{-1}$) higher grain yield than the conventional treatment ($T_1$). At the same time, CRM technologies i.e., happy seeder, surface seeding and residue incorporation, demonstrated synergistic effect with foliar application of potassium nitrate whereby reporting a hike of 16.65% (4.84 t $ha^{-1}$), 18.34% (4.91 t $ha^{-1}$) and 5.38% in grain yield relative to conventional sowing (4.15 t $ha^{-1}$), respectively.

### 3.3. *Correlation and regression analysis*

Analysis of data revealed highly significant positive correlation (r=0.449) between number of grains $ear^{-1}$ and grain yield (Table 3). Positive correlation between other yield attributes and grain yield was also recorded but it could not reach level of significance. Furthermore, positive correlation of ear length with number of grains $ear^{-1}$ (r=0.120) and 1000-grain weight (r=0.233) was also observed. Same in the line, highest value of regression coefficient was there in case of number of grains $ear^{-1}$ (0.409) followed by ear length (0.250) and ear number (0.182).

Table 2: Rate of change in grain yield of wheat due to potassium nitrate and residue retention techniques (CSTs)

| Treatment | Grain yield (t $ha^{-1}$) | ROI* by CRM technology over $T_1$ (%) | ROI by potassium nitrate over $T_1$ (%) | Additive effect of CSTs over $T_1$ (%) | ROI by $KNO_3$ over CRM technologies |
|---|---|---|---|---|---|
| $T_1$ | 4.15 | - | - | - | - |
| $T_2$ | 4.23 | - | 1.88 | 1.88 | - |
| $T_3$ | 4.79 | 15.57 | - | - | - |
| $T_4$ | 4.84 | - | 1.08 | 16.65 | 0.94 |
| $T_5$ | 4.81 | 15.98 | | - | - |
| $T_6$ | 4.91 | - | 2.36 | 18.34 | 2.04 |
| $T_7$ | 4.26 | 2.63 | | - | - |
| $T_8$ | 4.37 | - | 2.75 | 5.38 | 2.68 |
| LSD ($p$<0.05) | 0.38 | - | - | - | - |

* ROI: Rate of increase; CRM: Crop residue management; CSTs: Climate smart technologies

Table 3: Correlation matrix and regression coefficients of grain yield and yield attributes

| Parameters | Ear length | Ear number | Grain number | 1000-Grain weight | Grain yield | Regression coefficients |
|---|---|---|---|---|---|---|
| Ear length | 1.000 | $-0.008^{NS}$ | $0.120^{NS}$ | $0.233^{NS}$ | $0.095^{NS}$ | 0.250 |
| Ear number | $-0.008^{NS}$ | 1.000 | $0.137^{NS}$ | $0.059^{NS}$ | $0.288^{NS}$ | 0.182 |
| Grain number | $0.120^{NS}$ | $0.137^{NS}$ | 1.000 | $0.271^{NS}$ | $0.449^{**}$ | 0.409 |
| 1000- Grain weight | $0.233^{NS}$ | $0.059^{NS}$ | $0.271^{NS}$ | 1.000 | $0.229^{NS}$ | 0.112 |
| Grain yield | $0.095^{NS}$ | $0.288^{NS}$ | $0.449^{**}$ | $0.229^{NS}$ | 1.000 | - |

**Highly significant; NS: Non-significance at ($p$<0.05) level

## 4. Conclusion

Residue retention, either by surface seeding or by happy seeder technology, as a sole and in integration with foliar application of potassium nitrate improvised the grain yield, yield attributes and B:C of wheat crop. Correlation analysis showed that number of grains $ear^{-1}$ showed highly significant positive correlation with grain yield of wheat.

## 5. Acknowledgement

The authors acknowledge the ICAR-CRIDA, Hyderabad and Agricultural Technology Application Research Institute (ATARI), Zone-I, PAU Campus, Ludhiana for funding the project and providing platform to conduct this research.

## 6. References

Anonymous, 2012. Rice-wheat cropping systems in India and Australia and development of the Happy Seeder. ACIAR Impact Assessment Series Report No. 77. Australian Centre for International Agricultural Research. https://www.aciar.gov.au/sites/default/files/legacy/node/14496/ias077_rice_wheat_cropping_systems_in_india_and_12036.pdf. Accessed on 10th April, 2012.

Anonymous, 2017. Innovative viable solution to rice residue burning in rice-wheat cropping system through concurrent use of super straw management system-fitted combines and turbo Happy Seeder. Policy Brief No. 2. National Academy of Agricultural Sciences. https://naasindia.org/documents/CropBurning.pdf. Accessed on:September 10, 2019. https://naas.org.in/documents/CropBurning.pdf. Accessed on 24th October, 2017.

Anonymous, 2023. Package of practices for *rabi* crops. ISSN 2278-3709, Punjab Agricultural University, Ludhiana pp. 1–22. https://www.pau.edu/content/ccil/pf/pp_rabi.pdf. Accessed on 1st August, 2021.

Aryal, J.P., Sapkota, T.B., Stirling, C.M., Jat, M.L., Jat, H.S., Rai, M., Mittal, S., Sutaliya, J.M., 2016. Conservation agriculture based wheat production better copes with extreme climate events than conventional tillage-based systems: A case of untimely excess rainfall in Haryana, India. Agriculture, Ecosystems and Environment 233, 325–335.

Barua, U., Islam, M., Medhi, S., 2023. Awareness and adoption of climate resilient horticulture technologies by farmers in Ri Bhoi District of Meghalaya. International Journal of Economic Plants 10(4), 256–262.

Gadisa, A., Alemu, D., Negash, G., Tafesse, S., Abebe, D., Rut, D., Habtemariam, Z., Dawit, A., Abebe, G., Bayisa, A., Demeke, Z., Bekele, G.A., Ayele, B., Bedada, G., 2020. Development of bread wheat (*Triticum aestivum* L.) varieties for high moisture areas of Ethiopia: A G×E Interaction and stability analysis for grain yield.

Ethiopian Journal of Crop Sciences 8(1), 87–104.

Gathala, M.K., Laing, A., Tiwari, T.P., Timsina, J., Islam, M.S., Bhattacharya, P.M., Dhar, T., Ghosh, A., Sinha, A.K., Choudhary, A.K., Hossain, M.S., Hossain, I., Molla, M.S.H., Rashid, M.M., Kumar, S.S., Kumar, R., Dutta, S.K., Srivastwa, P.K., Choudhary, B., Jha, S.K., Ghimire, P., Bastola, B., Chaubey, R.K., Kumar, U., Gerard, B., 2020. Energy-efficient, sustainable crop production practices benefit smallholder farmers and the environment across three countries in the eastern gangetic plains, South Asia. Journal of Cleaner Production 246, 1182–1189.

Hussain, M., Butt, A.R., Uzma, F., Ahmed, R., Irshad, S., Rehman, A., Yousaf, B., 2020. A comprehensive review of climate change impacts, adaptation, and mitigation on environmental and natural calamities in Pakistan. Environmental Monitoring and Assessment 192(1), 1–20.

Jaidka, M., Brar, A.S., Singh, H., 2024. Production efficiency of rice wheat cropping system and path coefficient analysis of wheat under climate smart technologies. International Journal of Research in Agronomy 7(2), 504–508. https://www.agronomyjournals.com/article/view/359/7-2-74.

Jaidka, M., Sharma, M., Sandhu, P., 2020. Evaluation of rice residue management options in district Shaheed Bhagat Singh Nagar of Punjab- A Survey. Agricluture Research Journal 57(3), 358–362.

Kadam, D.M., Shrivastava, A.K., Gupta, R., Gautam, R., Rajak, S.K., 2023. Performance evaluation of tractor drawn happy seeder for sowing of wheat crop and comparative study with other sowing machines. The Pharma Innovation Journal 12(4), 249–255.

Karla, U., Choudhary, V.K., Singh, S.K., Vignesh, S., Ellandula, A., 2023. Assessing genetic variability in wheat (*Triticum aestivum* L.) under timely and late sown conditions for tolerance towards terminal heat stress. International Journal of Bio-resource and Stress Management 14(11), 1460–1466.

Lenka, S., Panigrahi, R.S., Mohapatra, B., Patnaik, B.R., 2022. Knowledge level of farmers on climate resilient agro-technologies curtail the climatic change effect in the NICRA district of Odisha. The Pharma Innovation Journal SP–11(4), 13–17.

Lenka, S., Patnaik, B.R., Dash, S.R., 2023. Impact of NICRA project on knowledge, skill and attitude (KSA) of farmers on climate-resilient agrotechnology's in the NICRA operated District of Odisha. International Journal of Bio-resource and Stress Management 14(1), 132–137.

Sidhu, H.S., Singh, M., Singh, Y., Blackwell, J., Lohan, S.K., Humphreys, E., Jat, M.L., Singh, V., Singh, S., 2015. Development and evaluation of the Turbo Happy Seeder for sowing wheat into heavy rice residues in NW India. Field Crops Research 184, 201–212.

Singh, K.M., Singh, H.K., 2020. Effect of foliar application of potassium nitrate on late sown wheat (*Triticum aestivum* L.) in mitigating terminal heat stress. Journal of Pharmacognosy and Phytochemistry SP6, 492–495.

Singh, S.K., Patra, A., Chand, R., Jatav, H.S., Luo, Y., Rajput, V.D., Sehar, S., Attar, S.K., Khan, M.A., Jatav, S.S., 2022. Surface seeding of wheat: a sustainable way towards climate resilience agriculture. Sustainability 14(12), 74–60.

Singh, Y., Singh, M., Sidhu, H.S., Humphreys, E., Thind, H.S., Jat, M.L., Blackwell, J., Singh, V., 2015. Nitrogen management for zero till wheat with surface retention of rice residues in north-west India. Field Crops Research 184, 183–191.

Taylor, M., Bhasme, S., 2021. Between deficit rains and surplus populations: The political ecology of a climate-resilient village in South India. Geoforum 126, 431–440.

Vijayakumar, S., Kumar, D., Shivay, Y.S., Anand, A., Saravanane, P., Singh, N., 2019. Potassium fertilization for enhancing yield attributes, yield and economics of wheat (*Triticum aestivum*). Indian Journal of Agronomy 64(2), 226–231.