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# Crop Establishment Methods and Weed Management Practices Effect on Nutrient Content and Their Uptake in Wheat (*Triticum aestivum* L.) in the Varanasi Region

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

A field study was carried out during two consecutive Rabi seasons in 2018–19 and 2019–20 at the Agricultural Research Farm of the Institute of Agricultural Sciences, Banaras Hindu University in Varanasi, Uttar Pradesh, India to evaluate the effectiveness of various tillage techniques and herbicides on the nutrient utilization of wheat. The treatments included different crop establishment

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techniques, such as conventional, reduced, and zero tillage, which were assigned to the main plot, and various weed management techniques, such as Carfentrazone-ethyl 40 %DF @ 10 g a.i. /ha; Carfentrazone-ethyl 40% DF @ 20 g a.i. /ha; Carfentrazone-ethyl 40 % DF @ 30 g a.i./ha; Carfentrazone-ethyl 40% DF @ 40 g a.i. /ha; 2,4-D Amine salt @ 750 g a.i./ ha; Metsulfuron methyl 20% WP @4 g a.i. /ha; Metsulfuron methyl 20% WP @6 g a.i. /ha; and Hand Weeding at 25 & 45 DAS were assigned to the subplot, which remained constant for both the years under Split Plot Design which was replicated three times. The result reveals that total N (58.03 and 31.10 kg/ha), P( 11.75and 2.656 kg/ha ) and K(17.25 and 77.47 kg/ha) content of grain and straw, respectively in 2018-19 and N (61.41 and 31.60 kg/ha), P( 11.89and 2.849 kg/ha ) and K(17.48 and 77.89 kg/ha) content of grain and straw, respectively in 2019-20 , was significantly higher in carfentrazone-ethyl @ 30 g a.i. /ha after hand weeding at 25 & 45 DAS over rest other treatments but was at par with carfentrazone-ethyl @ 20 g a.i. /ha and metsulfuron methyl 20 % WP@ 8 g a.i. /ha. Also N (56.39 and 29.96 kg/ha), P(11.72 and 2.594 kg/ha) and K(16.75 and 76.71 kg/ha) uptake by the grain and wheat straw , respectively in 2018-19 and N (59.87and 30.41kg/ha), P(11.82 and 2.801kg/ha) and K (17.04 and 76.91 kg/ha) uptake by grain and straw, respectively in 2019-20 under metsulfuron methyl 20 % WP@ 8 g a.i. /ha was statistically at par with that of metsulfuron methyl 20%WP @ 6 g a.i. /ha. Wheat treated with carfentrazone-ethyl @ 30 g a.i. /ha produced higher grain protein yield (36.27 and 38.38 kg/ha) in 2018-19 and 2019-20 , respectively which was at par with carfentrazone-ethyl @ 20 g a.i. /ha and metsulfuron methyl 20 % WP@ 8 g a.i. /ha.

*Keywords: Nutrients; nitrogen; potassium; protein yield; carfentrazone-ethyl.*

## 1. INTRODUCTION

Wheat is cultivated on a large scale through conventional tillage in the Indo-Gangetic Plains of Uttar Pradesh as second most consumed cereal after rice. Sub continental farmers cultivate it extensively in order to satisfy anticipated demand for both export and consumption. Uttar Pradesh, contributed 32.74 and 32.59 million tonnes from an area of 9.54 and 9.50 million hectares, in the country during the most recent 2018–19 and 2019-20 seasons, respectively, with a consistent productivity of 3432 kg/hectares in both years (Anonymous, 2020). The main causes of this wheat productivity stagnation include excessive tillage, declining soil health and weed-related problems (Choudhary et al., 2010). “One of the most significant factors affecting wheat output is weeds, which can reduce yield by 15% to 50%, depending on the relative amount of plant flora, weed density, and duration of infestation” (Kumar et al., 2021). The predicted annual decline in wheat yield could also be ascribed to unfavorable climate change, water scarcity, weed infestation, and disease (Seth et al., 2020).

“The availability of nutrients in the soil rhizosphere, in addition to the management techniques, is a major factor in controlling crop productivity. Crop uptake of nutrients (N, P, and K) depends on the amount of dry matter accumulated per unit area and the nutrient content of the plant” (Kanthi et al., 2014). The characteristics of the soil and crop yields are positively impacted by tillage techniques (Alam et al., 2014). “Following four cropping cycles, the conservational tillage techniques shows the largest organic matter accumulation, the maximum root mass density (0–15 cm soil depth), and the enhanced physical and chemical qualities” (Jain et al., 2007). A reduction in the soil erosion and increase in topsoil organic matter has been reported under reduced tillage (Bouyoucos, 1973). If weeds are controlled and a healthy supply of nutrients is guaranteed, reduced tillage can give winter wheat grown organically the yields that are on par with or even higher than conventional tillage (Merel et al., 2019).

Controlling weeds effectively is crucial for preventing nutrient losses as well as weed-related yield losses. Weeds are a significant problem in wheat production and can reduce crop productivity by up to 66% if left unchecked (Singh et al., 2015). “Weeds are reported to deplete nutrients by up to 24.3-28.6% N, 13.5 16.2% P, and 22.3-25.2% K” (Pandey et al., 2001). “In comparison to weed-free plots, the crop's uptake of N, P, and K was 56, 45, and 60% less when weeds were let to grow throughout the growing season” (Johri et al., 1992). The loss of nutrients may be significantly reduced by using herbicides and tillage together (Jain et al., 2007). Thus, the goal of the current study was to determine how crop establishment techniques and weed control strategies affected the quality and nutrient utilization of wheat.

## 2. MATERIALS AND METHODS

### 2.1 Experimental Site

The present study was carried out during two consecutive Rabi seasons in 2018–19 and 2019–20 at the Agricultural Research Farm of the Institute of Agricultural Sciences in Varanasi, Uttar Pradesh. The sandy clay loam-textured soil in the experimental fields had a neutral pH, a medium amount of accessible potassium and phosphorus, and low levels of organic carbon and nitrogen. "HUW-234" was the wheat variety cultivated in both research years. In all treatments, 150 kg N, 60 kg P2O5, and 60 kg K2O of the recommended fertilizer dosage for wheat were applied in the form of urea (46% N), DAP (18% N & 46% P2O5), and muriate of potash (60% K2O), respectively.

### 2.2 Experimental Design

The primary plot of the experimental treatments included various crop establishment techniques, such as conventional, reduced, and zero tillage in addition to several weed control techniques like Carfentrazone- ethyl 40 % DF @ 10 g a.i. /ha; Carfentrazone- ethyl 40 % DF @ 20 g a.i. /ha, Carfentrazone- ethyl 40 % DF @ 30 g a.i. /ha, Carfentrazone- ethyl 40 % DF @ 40 g a.i. /ha, 2,4-D Amine salt @ 750 g a.i. /ha, Metsulfuron methyl 20% WP (4 g a.i. /ha), Metsulfuron methyl 20% WP (6 g a.i. /ha) ,Metsulfuron methyl 20% WP (8 g a.i. /ha), Hand Weeding at 25 & 45 DAS and Weedy check in the sub plot which remained same for both the years under Split Plot Design (SPD) and were replicated thrice. Statistical analysis of variance method of Split Plot Design was used as per Gomez and Gomez (2003) to obtain the effect of different treatments as well as treatment effect of different combination in all the above observations.

### 2.3 Soil Dynamics Study

In order to analyze the chemical, physical, and biological characteristics of the soil prior to conducting the experiments, soil samples were taken from both investigation locations at a depth of 0–20 cm, using all the required procedures for soil sampling as outlined by Black et al., (1965). To evaluate the soil's initial physical, chemical, and biological characteristics, the samples were thereafter allowed to air dry before being sieved through a 20 mm mesh screen and subjected to additional mechanical, chemical, and biological studies. The outcomes of the analyses and the methods used are displayed in Table 1.

### 2.4 Sample Preparation

Nitrogen, phosphorus, and potassium analyses were performed on grain and straw samples from each treatment during harvest. Following a 24-hour drying period in the open, these samples were dried in a hot air oven set at 65±5°C until they reached a consistent weight. Once a consistent weight was reached, the oven-dried samples were stored in butter paper covers after being ground individually according to the treatments using Willey's mill. Chemical analysis was performed using the powdered samples after they had been run through a 2 mm sieve.

### 2.5 Plant Sample Digestion

In order to digest the plant samples, 0.5 grams of plant material were added to a 100 ml conical flask, and then 10 ml of a di-acid combination (10:4 of nitric acid ($HNO_3$) and per chloric acid ($HClO_4$), respectively). After that, the samples were heated progressively on a hot plate for 30 minutes to reach the maximum temperature of 200°C in order to exhaust the HNO3 and release the white vapors of perchloric acid from the flask. The flask was then allowed to cool. Following the addition of 30 to 40 milliliters of distilled water, the digested sample was filtered using Whatman No. 42 filter paper. Following the transfer of the filtrate to a volumetric flask, distilled water was added to reach the final volume of 100 ml.

### 2.6 Nutrient Content (%) and Uptake by Wheat (kg /ha)

#### 2.6.1 Total nitrogen (kg /ha)

System for automatically estimating nitrogen in automated digestion and distillation was used to estimate the total nitrogen content through Micro-kjeldahl method by using KEL PLUS according to the analytical method by AOAC (1995). The components of this system include macro block digestion system, automatic distillation system, acid neutralizer scrubber and condensation unit consisting of refrigerated water cooling system (Thakur et al., 2012). The nitrogen content of grain and straw (%) was multiplied by their respective yields to determine the total nitrogen intake, which was then expressed in kg/ ha.

#### 2.6.2 Total phosphorus (kg / ha)

The total phosphorus in the di-acid digested grain and straw samples was ascertained using the Vanado-molybdo-phosphoric acid yellow color method (Koenig & Johnson, 1942). The total phosphorus intake was determined by multiplying the phosphorus content of grain and straw (%) by their respective yields, and it was represented in kilograms per hectare. The spectrophotometer employed a blue filter at 440 nm wave length to observe the intensity of color.

#### 2.6.3 Total potassium (kg/ ha)

As Jackson (1973) explains, a flame photometer was used to measure the total potassium in the acid-digested grain and straw samples. By multiplying the potassium content (%) by the corresponding yields, the potassium uptake by grain and straw was calculated and expressed in kilograms per hectare.

### 2.7 Protein Content (%) and Protein Yield (kg/ ha) in Wheat Grain

Using the Kjeldahl method as per AOAC (1995), the protein content of wheat grain was computed by multiplying 6.25 (factor) by the nitrogen concentration in each plot's grains.

Protein content (%) = N content in grain × 6.25

Nevertheless, the protein yield of wheat grain was determined by multiplying the grain yield by the protein content. For all of the aforementioned data, the effect of various treatments as well as the treatment effect of various combinations was obtained using the statistical analysis of variance method of Split Plot Design (SPD), as per Gomez and Gomez (2003).

## 3. RESULTS AND DISCUSSION

### 3.1 Effect of Crop Establishment and Weed Management Practices on N, P and K Uptake of Wheat

The soil of the experimental field was sandy clay loam in texture, neutral in pH (7.32 and 7.27) with low organic carbon (0.319 and 0.327%) and available nitrogen (208 and 219.6 kg $ha^{-1}$) and medium in available phosphorus (17 and 18.4 kg $ha^{-1}$) and potassium (190.39 and 193.74 kg $ha^{-1}$). The soil microbial population of actinomycetes (39 and 36.5 cfu x $10^4$ $g^{-1}$ soil), bacteria (110 and 107 cfu x $10^6$ $g^{-1}$ soil) and fungi (26 and 30 cfu x $10^4$ $g^{-1}$ soil) indicates good soil health prior to conductance of the experimentations in the wheat field during both the *Rabi* seasons of 2018-19 and 2019-20, respectively as depicted in Table 1.

The nutrients (N,P and K ) content in both grain and straw was not significantly affected by the tillage practices as well as the weed management practices during both the years of investigations as depicted in Table 2. The impact of crop establishing techniques on the uptake of nitrogen (N), phosphorus (P), and potassium (K) by wheat grain and straw throughout both investing years, was not statistically significant.

However, among the weed management practices significantly higher uptake of Nitrogen (N), Phosphorus (P) and Potassium (K) by both the grain and straw of wheat was recorded by carfentrazone-ethyl @ 30 g a.i. /ha (58.03 kg $ha^{-1}$ N , 11.75 kg $ha^{-1}$P and 17.25 kg $ha^{-1}$ K in grain and 31.10 kg $ha^{-1}$ N , 2.66 kg $ha^{-1}$ P and 77.47 kg $ha^{-1}$ K in straw ), after hand weeding at 25 & 45 DAS which was at par with carfentrazone-ethyl @ 20 g a.i. /ha and metsulfuron methyl 20 % WP@ 8 g a.i. /ha in the year 2018-19. Further, Nitrogen (N), Phosphorus (P) and Potassium (K) uptake by both the grain and straw of wheat recorded under metsulfuron methyl 20 % WP@ 8g a.i. /ha (56.39 kg $ha^{-1}$ N , 11.72 kg $ha^{-1}$P and 16.75 kg $ha^{-1}$ K in grain and 29.96 kg $ha^{-1}$ N , 2.59 kg $ha^{-1}$ P and 76.61 kg $ha^{-1}$ K in straw)was statistically at par with that of metsulfuron methyl 20%WP @ 6 g a.i. /ha during first year of experimentation. Similar trend in the nutrient uptake by both grain and straw was observed among the treatments in the year 2019-20. The significantly lower nutrients uptake in wheat grain and straw was observed in weedy check as compared to rest of all treatments during both the years of studies. The interactions effect of the crop establishment methods and the weed management practices was statistically non-significant on the N, P and K uptake by wheat grain and straw and grain protein yield during both the years of experimentation. With decreased weed density and dry matter and increased weed control efficiency the N, P and K uptake by wheat crop was enhanced under all the herbicide treated plots as compared to weedy check. Similar findings were reported by Khokhar and Nepalia (2010).

### 3.2 Effect of Crop Establishment Methods and Weed Management Practices on Protein Content in Grain and Protein Yield

Wheat establishment methods and the weed control measures did not produce any significant influence on the protein content (%) however protein yield of the grain was significantly affected by the weed management practices during both the years of investigations as shown in Tables 4. Further, there was statistically non-significant interaction effects between crop establishment methods and the weed management practices on the protein content (%) and protein yield during both the investigating years.

Among the weed management practices the spraying of carfentrazone ethyl @ 30 g a.i. ha$^{-1}$ (36.27 and 38.38 kg ha $^{-1}$) recorded significantly higher grain protein yield over carfentrazone ethyl @ 10 and 40 g a.i. ha$^{-1}$, metsulfuron methyl 20 % WP @ 4 g a.i. ha$^{-1}$, 2,4-D Amine salt @ 750 g a.i. ha$^{-1}$ and weedy check and was statistically at par with hand weeding at 25 & 45 DAS (37.67 and 39.21 kg ha $^{-1}$ ) , carfentrazone ethyl @ 20 g a.i.ha$^{-1}$(34.67 and 36.15 kg ha $^{-1}$ ), metsulfuron methyl 20 % WP @ 8 g a.i. ha$^{-1}$(35.24 and 37.42 kg ha $^{-1}$). Further the above quality parameter of wheat recorded by metsulfuron methyl 20 % WP @ 8 g a.i. ha$^{-1}$ was also statistically at par with @ 6 g a.i. ha$^{-1}$ (34.19 36.34 kg ha $^{-1}$) during both the years of investigation of 2018-19 and 2019-20, respectively. With decreased weed density and dry matter and increased weed control efficiency the N uptake by wheat crop was enhanced under all the herbicide treated plots as compared to weedy check and hence the protein yield. This finding is in line with the studies conducted by Khokhar and Nepalia (2010).

**Table 1. Physical-Mechanical composition of the soil of experimental field**

| S.No. | Particulars | Values: Pre experimental study of soil of experimental field 2018-19 | 2019-20 | Methods/Procedures applied |
|---|---|---|---|---|
| **A.** | **Physical Properties** | | | |
| 1. | Sand (%) | 51.68 | 51.23 | Hydrometric method (Bouyoucos,1962) |
| | Silt (%) | 21.99 | 22.54 | |
| | Clay (%) | 25.38 | 25.21 | |
| | Textured class | Sandy clay loam | Sandy clay loam | |
| 2. | Bulk density (Mgm$^{-3}$) | 1.357 | 1.361 | Soil core sampler method (Piper,1967) |
| **B.** | **Chemical composition** | | | |
| 1. | pH (1:2.5, Soil: water) | 7.32 | 7.27 | Glass electrode pH meter (Jackson,1973) |
| 2. | Organic carbon (%) | 0.319 | 0.327 | Walkley and Black rapid tritration method (Jackson, 1973) |
| 3. | Electrical conductivity (dS m$^{-1}$ ) | 0.218 | 0.229 | Systronics Electrical Conductivity meter (Jackson, 1973) |
| 4. | Available nitrogen (kg /ha) | 208 | 219.6 | Alkaline permanganate method (Subbiah & Asija, 1956) |
| 5. | Available phosphorus (kg /ha) | 17 | 18.4 | 0.5NNaHCO3 Extractable (Olsen *et al.,* 1954) |
| 6. | Available potassium (kg /ha) | 190.39 | 193.74 | Ammonium acetate extractable flame photometer (Jackson,1973) |
| **C.** | **Total soil microbial population** | | | |
| 1. | Actinomycetes (cfux10$^{4}$g$^{-1}$soil) | 39 | 36.5 | Thornton's medium (Chhonkar *et al.,*2007) |
| 2. | Bacteria (cfux10$^{6}$g$^{-1}$ soil) | 110 | 107 | Kenknight and Munaier's medium (Chhonkar *et al.,* 2007) |
| 3. | Fungi (cfux10$^{4}$g$^{-1}$ soil) | 26 | 30 | Martin's Rose Bengal medium (Chhonkar *et al.,* 2007) |

**Table 2. Effect of crop establishment methods and weed management practices on Nitrogen (N) Phosphorus (P) and Potassium (K) content of wheat**

| Treatments | Nitrogen content ( %) | | | | Phosphorus content ( %) | | | | Potassium content ( %) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grain | | Straw | | Grain | | Straw | | Grain | | Straw | |
| | 2018-19 | 2019-20 | 2018-19 | 2019-20 | 2018-19 | 2019-20 | 2018-19 | 2019-20 | 2018-19 | 2019-20 | 2018-19 | 2019-20 |
| **Crop Establishment Methods** | | | | | | | | | | | | |
| Conventional Tillage | 1.42 | 1.47 | 0.49 | 0.49 | 0.279 | 0.287 | 0.038 | 0.047 | 0.416 | 0.425 | 1.240 | 1.260 |
| Reduced Tillage | 1.41 | 1.46 | 0.47 | 0.48 | 0.278 | 0.285 | 0.036 | 0.041 | 0.406 | 0.405 | 1.230 | 1.247 |
| Zero Tillage | 1.40 | 1.44 | 0.44 | 0.46 | 0.278 | 0.280 | 0.035 | 0.037 | 0.401 | 0.403 | 1.220 | 1.244 |
| SEm± | 0.01 | 0.01 | 0.01 | 0.01 | 0.004 | 0.008 | 0.003 | 0.004 | 0.010 | 0.014 | 0.008 | 0.011 |
| C.D.(P=0.05) | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| **Weed Management Practices** | | | | | | | | | | | | |
| Carfentrazone-ethyl @ 10 g a.i. /ha | 1.38 | 1.42 | 0.44 | 0.44 | 0.274 | 0.277 | 0.031 | 0.038 | 0.395 | 0.397 | 1.207 | 1.224 |
| Carfentrazone-ethyl @ 20 g a.i. /ha | 1.41 | 1.45 | 0.47 | 0.48 | 0.280 | 0.281 | 0.037 | 0.041 | 0.406 | 0.417 | 1.229 | 1.262 |
| Carfentrazone-ethyl @ 30 g a.i. /ha | 1.44 | 1.49 | 0.50 | 0.52 | 0.286 | 0.290 | 0.043 | 0.047 | 0.420 | 0.426 | 1.253 | 1.278 |
| Carfentrazone-ethyl @ 40 g a.i. /ha | 1.39 | 1.43 | 0.45 | 0.46 | 0.278 | 0.279 | 0.034 | 0.039 | 0.400 | 0.405 | 1.214 | 1.242 |
| 2,4-D Amine salt @ 750 g a.i. /ha | 1.39 | 1.44 | 0.44 | 0.46 | 0.263 | 0.277 | 0.031 | 0.038 | 0.400 | 0.393 | 1.204 | 1.221 |
| Metsulfuron methyl @ 4 g a.i. /ha | 1.41 | 1.45 | 0.46 | 0.47 | 0.274 | 0.281 | 0.033 | 0.038 | 0.407 | 0.413 | 1.226 | 1.249 |
| Metsulfuron methyl @ 6 g a.i. /ha | 1.42 | 1.47 | 0.48 | 0.49 | 0.280 | 0.286 | 0.037 | 0.040 | 0.414 | 0.421 | 1.242 | 1.256 |
| Metsulfuron methyl @ 8 g a.i. /ha | 1.43 | 1.48 | 0.49 | 0.50 | 0.291 | 0.294 | 0.042 | 0.046 | 0.416 | 0.424 | 1.252 | 1.271 |
| Hand weeding at 25 & 45 DAS* | 1.46 | 1.50 | 0.51 | 0.52 | 0.293 | 0.305 | 0.043 | 0.048 | 0.423 | 0.428 | 1.255 | 1.278 |
| Weedy check | 1.36 | 1.42 | 0.43 | 0.44 | 0.264 | 0.272 | 0.032 | 0.037 | 0.395 | 0.387 | 1.194 | 1.216 |
| SEm± | 0.02 | 0.02 | 0.02 | 0.02 | 0.009 | 0.014 | 0.003 | 0.003 | 0.013 | 0.020 | 0.016 | 0.016 |
| C.D. (P=0.05) | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| Interaction | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |

**Table 3. Effect of crop establishment methods and weed management practices on Nitrogen (N) Phosphorus (P) and Potassium (K) uptake of wheat**

| Treatments | Nitrogen uptake ( kg /ha) | | | | Phosphorus uptake ( kg /ha) | | | | Potassium uptake ( kg /ha) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grain | | Straw | | Grain | | Straw | | Grain | | Straw | |
| | 2018-19 | 2019-20 | 2018-19 | 2019-20 | 2018-19 | 2019-20 | 2018-19 | 2019-20 | 2018-19 | 2019-20 | 2018-19 | 2019-20 |
| **Crop establishment methods** | | | | | | | | | | | | |
| Conventional Tillage | 53.92 | 57.34 | 28.88 | 28.73 | 10.91 | 11.24 | 2.255 | 2.730 | 16.24 | 16.67 | 73.03 | 73.47 |
| Reduced Tillage | 52.39 | 55.71 | 27.40 | 27.86 | 10.61 | 10.89 | 2.084 | 2.358 | 15.51 | 15.47 | 71.40 | 72.00 |
| Zero Tillage | 51.25 | 53.72 | 25.44 | 26.19 | 10.35 | 10.37 | 2.021 | 2.076 | 14.93 | 15.03 | 69.65 | 70.53 |
| SEm± | 0.73 | 0.94 | 0.94 | 0.51 | 0.15 | 0.30 | 0.202 | 0.219 | 0.39 | 0.53 | 0.87 | 0.85 |
| C.D.(P=0.05) | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| **Weed Management Practices** | | | | | | | | | | | | |
| Carfentrazone-ethyl @ 10 g a.i. /ha | 48.13 | 48.93 | 24.46 | 23.08 | 9.44 | 9.56 | 1.742 | 2.017 | 13.64 | 13.73 | 66.94 | 64.56 |
| Carfentrazone-ethyl @ 20 g a.i. /ha | 55.46 | 57.85 | 27.91 | 28.56 | 11.15 | 10.97 | 2.245 | 2.451 | 16.16 | 16.62 | 73.48 | 75.04 |
| Carfentrazone-ethyl @ 30 g a.i. /ha | 58.03 | 61.41 | 31.10 | 31.60 | 11.75 | 11.89 | 2.656 | 2.849 | 17.25 | 17.48 | 77.47 | 77.89 |
| Carfentrazone-ethyl @ 40 g a.i. /ha | 52.11 | 54.18 | 25.98 | 26.68 | 10.49 | 10.55 | 1.954 | 2.234 | 15.11 | 15.34 | 70.56 | 71.87 |
| 2,4-D Amine salt @ 750 g a.i. /ha | 44.18 | 51.31 | 22.53 | 24.68 | 9.40 | 9.94 | 1.579 | 2.064 | 14.31 | 14.10 | 61.21 | 65.64 |
| Metsulfuron methyl @ 4 g a.i. /ha | 53.11 | 52.79 | 27.54 | 27.28 | 9.94 | 10.22 | 1.933 | 2.242 | 14.86 | 15.09 | 72.70 | 72.76 |
| Metsulfuron methyl @ 6 g a.i. /ha | 54.71 | 58.15 | 28.68 | 29.15 | 11.08 | 11.32 | 2.196 | 2.340 | 16.36 | 16.67 | 74.52 | 74.38 |
| Metsulfuron methyl @ 8 g a.i. /ha | 56.39 | 59.87 | 29.96 | 30.41 | 11.72 | 11.82 | 2.594 | 2.801 | 16.75 | 17.04 | 76.71 | 76.91 |
| Hand weeding at 25 & 45 DAS* | 60.28 | 62.74 | 31.95 | 31.80 | 12.23 | 12.72 | 2.669 | 2.958 | 17.62 | 17.87 | 78.09 | 78.32 |
| Weedy check | 42.83 | 48.68 | 22.30 | 22.66 | 9.03 | 9.34 | 1.633 | 1.922 | 13.54 | 13.27 | 61.91 | 62.62 |
| SEm± | 1.33 | 1.49 | 1.47 | 1.26 | 0.39 | 0.52 | 0.201 | 0.197 | 0.54 | 0.80 | 1.46 | 1.54 |
| C.D. (P=0.05) | 3.76 | 4.24 | 4.14 | 3.56 | 1.10 | 1.48 | 0.570 | 0.559 | 1.54 | 1.14 | 4.14 | 4.37 |
| Interaction | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |

**Table 4. Effect of crop establishment methods and weed management practices on protein content and protein yield of wheat grain**

| Treatments | Protein content Grain ( %) | | Protein yield ( kg /ha) | |
|---|---|---|---|---|
| | 2018-19 | 2019-20 | 2018-19 | 2019-20 |
| **Crop establishment methods** | | | | |
| Conventional Tillage | 8.84 | 9.17 | 33.70 | 35.84 |
| Reduced Tillage | 8.80 | 9.12 | 32.75 | 34.82 |
| Zero Tillage | 8.78 | 9.03 | 32.03 | 33.57 |
| SEm± | 0.07 | 0.07 | 0.43 | 0.65 |
| C.D.(P=0.05) | NS | NS | NS | NS |
| **Weed management practices** | | | | |
| Carfentrazone-ethyl @ 10 g a.i. /ha | 8.62 | 8.88 | 30.08 | 30.58 |
| Carfentrazone-ethyl @ 20 g a.i. /ha | 8.83 | 9.08 | 34.67 | 36.15 |
| Carfentrazone-ethyl @ 30 g a.i. /ha | 9.00 | 9.34 | 36.27 | 38.38 |
| Carfentrazone-ethyl @ 40 g a.i. /ha | 8.69 | 8.95 | 32.57 | 33.86 |
| 2,4-D Amine salt @ 750 g a.i. /ha | 8.66 | 8.98 | 27.61 | 32.07 |
| Metsulfuron methyl @ 4 g a.i. /ha | 8.79 | 9.09 | 33.19 | 32.99 |
| Metsulfuron methyl @ 6 g a.i. /ha | 8.88 | 9.19 | 34.19 | 36.34 |
| Metsulfuron methyl @ 8 g a.i. /ha | 8.96 | 9.28 | 35.24 | 37.42 |
| Hand weeding at 25 & 45 DAS* | 9.13 | 9.39 | 37.67 | 39.21 |
| Weedy check | 8.52 | 8.90 | 26.77 | 30.43 |
| SEm± | 0.14 | 0.14 | 0.74 | 1.07 |
| C.D. (P=0.05) | NS | NS | 2.10 | 3.02 |
| Interaction | NS | NS | NS | NS |

**DAS: Days after sowing; NS: Non-significant*

## 4. CONCLUSION

The aforementioned results suggest that wheat treated with carfentrazone-ethyl @ 30 g a.i. /ha harvested significantly higher N, P, K uptake and grain protein yield following hand weeding at 25 & 45 DAS. This yield was comparable to that of carfentrazone-ethyl @ 20 g a.i. /ha and metsulfuron methyl 20% WP @ 8 g a.i. /ha, and it was significantly higher than the other treatments. Additionally, the uptake of N, P, and K by the grain and wheat straw under metsulfuron methyl 20% WP@ 8 g a.i. /ha was statistically comparable to that under metsulfuron methyl 20%WP @ 6 g a.i. /ha. Therefore, It can be recommended that application of carfentrazone- ethyl 40% DF @20 g a.i. /ha or metsulfuron methyl @ 6 g a.i. /ha should be used as post emergence herbicide for managing broad leaf weeds under zero tillage and to obtain higher yield and economic net returns.

## DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.


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## COMPETING INTERESTS

Authors have declared that they have no known competing financial interests or non-financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## REFERENCES


Alam, K. M., Islam, M. M., Salahin, N., & Hasanuzzaman, M. (2014). Effect of tillage practices on soil properties and crop productivity in Wheat-Mungbean-Rice cropping system under subtropical climatic conditions. *The Scientific World Journal*, 1–15.

Anonymous. (2020). *Directorate of Economics & Statistics, DAC & FW, Agricultural Statistics at a Glance 2020*. Government of India, Ministry of Agriculture and Farmers Welfare, Department of Agriculture, Cooperation & Farmers Welfare, Directorate of Economics & Statistics, 51.

AOAC. (1995). *Official methods of analysis* (16th ed.). Association of Official Analytical Chemists, Washington, DC.

Black, C. A., Evans, D. D., White, J. E., Ensminger, L. E., & Clark, F. E. (1965). *Methods of soil analysis, Part I, physical and microbiological properties including statistics of measurement and sampling*. American Society of Agronomy, 677.

Bouyoucos, G. J. (1962). Hydrometer method improved for making particle size analyses of soils. *Agronomy Journal, 54*:464-465.

Bouyoucos, G. J. (1973). Evaporation water with burning olconal as a rapid means of determining moisture content of soil. *Soil Science*, *44*, 337–383.

Chhonkar, P. K., Bhadraray, S., Patra, A. K., & Purakayastha, T. J. (2007). *Experiments in soil biology and biochemistry*. Westville Publishing House, New Delhi, 1–21.

Choudhary, A. K., Singh, A., & Yadav, D. S. (2010). On farm testing of wheat cultivars for site-specific assessment under varied bio-physical regimes in mid-hill conditions of Mandi district of Himachal Pradesh. *Journal of Community Mobilization and Sustainable Development*, *5*(1), 1–6.

Gomez, K. A., & Gomez, A. A. (2003). *Statistical procedure for agricultural research*. John Wiley and Sons, London, 139–167, 204–207.

Jackson, M. L. (1973). *Soil chemical analysis*. Prentice Hall Pvt. Ltd., New Delhi.

Jain, N., Mishra, J. S., Kewat, M. L., & Jain, V. (2007). Effect of tillage and herbicides on grain yield and nutrient uptake by wheat (*Triticum aestivum*) and weeds. *Indian Journal of Agronomy*, *52*(2), 131–134.

Johri, A. K., Singh, G., & Sharma, D. (1992). Weed management with respect to nutrient uptake in wheat. *Indian Journal of Weed Science*, *24*(3&4), 60–67.

Kanthi, M., Sandhya, Ramana, A. V., Murthy, K. V., & Ramana. (2014). Effect of different crop establishment techniques and nutrient doses on nutrient uptake and yield of rice (*Oryza sativa* L.). *Karnataka Journal of Agricultural Science*, *27*(3), 293–295.

Khokhar, A. K., & Nepalia, V. (2010). Effect of herbicides and nutrient management on weed flora, nutrient uptake and yield of wheat (*Triticum aestivum*) under irrigated conditions. *Indian Journal of Weed Science*, *42*, 14–18.

Koenig, R. A., & Johnson, C. R. (1942). Colorimetric determination of biological materials. *Indian Eng. Chem. Analyt. Edn.*, *14*, 155–156.

Kumar, V., Bana, R. S., Singh, T., & Louhar, G. (2021). Ecological weed management approaches for wheat under rice–wheat cropping system. *Environmental Sustainability*, *4*(1), 51–61.

Merel, Hofmeijer, A. J., Maike, K., Alfred, B., Joséphine, P., Paul, M., & Laura, A. (2019). Effects of reduced tillage on weed pressure, nitrogen availability and winter wheat yields under organic management. *Agronomy*, *9*, 180.

Olsen, S. R., Cole, C. V., Watanabe, F. S., & Dean, L. A. (1954). Estimation of available phosphorus in soil by extraction with sodium bicarbonate. *U.S. Department of Agriculture Circular*, *939*, 19–23.

Pandey, I. B., Sharma, S. L., Tiwari, S., & Bharati, V. (2001). Effect of tillage and weed management on grain yield and nutrients removal by wheat (*Triticum aestivum*) and weeds. *Indian Journal of Weed Science*, *33*(3&4), 107–111.

Piper, C. S. (1967). *Soil and plant analysis*. Asia Publishing House, Bombay, New Delhi, 30–38.

Seth, M., Manuja, S., & Singh, S. (2020). Effect of tillage and site specific nutrient management on yield, nutrient uptake and status of soil in wheat in rice-wheat cropping system. *Journal of Crop and Weed*, *16*(3), 32–37.

Singh, R., Singh, A. P., Chaturvedi, S., Rekha, Pal, R., & Pal, J. (2015). Metribuzin + clodinafop-propargyl effects on complex weed flora in wheat and its residual effect on succeeding crop. *Indian Journal of Weed Science*, *47*(4), 362–365.

Subbiah, B. V., & Asija, G. L. (1956). A rapid procedure for the determination of available N in soils. *Current Science*, *25*, 259–260.

Thakur, R. K., Baghel, S. S., Sharma, G. D., Sahu, R. K., & Amule, P. C. (2012). *Laboratory manual on advance in agro-technologies for improving soil, plant and atmosphere system*. Centre of Advanced Faculty Training, Department of Soil Science and Agricultural Chemistry, Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur (in: Determination of available mineralisation nitrogen in soil alkaline permanganate method. Upadhyay, A. K. and Sahu, Rakesh, 2012), 16–17.



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