Effect of fertility levels and weed management practices on yield and economics of wheat crop
(Triticum aestivum L.)

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Abstract
The field experiment was conducted during the rabi season of 2018–19 and 2019–20 at Agronomy Research Farm of Acharya Narendra Deva University of Agriculture & Technology, Narendra Nagar (Kumarganj), Ayodhya, U.P. with two factor, 3 fertility levels (100% RDF through inorganic fertilizer, 75% RDF through inorganic + 25% N through FYM and 50% RDF through inorganic + 50% N through FYM) and 5 weed control practices (Sulfosulfuron + Metsulfuron @ 30 g a.i. + 4 g a.i. ha⁻¹, Clodinafop + Metsulfuron @ 60 g a.i. + 4 g a.i. ha⁻¹, Mesosulfuron + Iodosulfuron @ 12.2 g a.i + 4.4 g a.i. ha⁻¹, weed free upto 60 Days and Weedy check). The treatments were replicated three times in a factorial randomized block design with fifteen treatment combinations. Among the treatment combinations 100% RDF (NPK-150:50:40) with weed free upto 60 days was recorded maximum value of grain yield, straw yield, biological yield, gross returns and net returns during both the years. Higher benefit cost ratio was recorded with the treatment combinations of 100% RDF and Sulfosulfuron + Metsulfuron @ 30 g a.i. + 4 g a.i. ha⁻¹. Thus, it may be concluded that application of 100% recommended dose of NPK ha⁻¹ with Sulfosulfuron + Metsulfuron @ 30 g a.i. + 4 g a.i. ha⁻¹ as proved most superior to other treatment in respect to higher benefit cost ratio of wheat crop.

Keywords: Fertility levels, weed management, yield and economics of wheat

Introduction
Wheat is one of the most important stable foods and prime cereal crop among the food-grain was grown in an area of 30 m ha in India, with the production 99.70 million tonnes and average productivity 33.71 q ha⁻¹ (Ramadas et al. 2019) [6]. Though it is grown under a wide range of climates and soils but wheat is best adapted to temperate regions with rainfall between 30 and 90 cm.

Wheat crop is highly responsive to applied nutrient through various sources; A proper fertility management is an important parameter for optimizing the productivity. Despite the past gains in wheat production through chemical fertilizers, recent observations of stagnant or declining yields have raised concerns about the long-term sustainability of the crop production. Continuous use of inorganic fertilizers leads to deterioration in soil chemical, physical, and biological properties, and soil health. The negative impacts of chemical fertilizers, coupled with escalating prices, have led to growing interests in the use of organic fertilizers as a source of nutrients. Organic materials such as FYM have traditionally been used by wheat farmers. FYM supplies all major nutrients (N, P, K, Ca, Mg, S,) necessary for plant growth, as well as micronutrients (Fe, Mn, Cu and Zn). Hence, it acts as a mixed fertilizer. FYM improves soil physical, chemical and biological properties. Improvement in the soil structure due to FYM application leads to a better environment for root development. FYM also improves soil water holding capacity. The fact that the use of organic fertilizers improves soil structure, nutrient exchange, and maintains soil health has raised interests in organic farming. The use of FYM alone as a substitute to inorganic fertilizer is not enough to maintain the present levels of wheat crop productivity. Therefore, integrated nutrient management in which both organic manures and inorganic fertilizers are used simultaneously is the most effective method to maintain a healthy and sustainably productive soil.
In general, the application of organic amendments such as crop residues and/or farmyard manure increases significantly soil organic carbon (Yadav et al., 2000) [11]. Weed problem is one of the major barriers responsible for low productivity of wheat because, weed competes with the crop for moisture, nutrients, space, light etc. Moreover, they increase production cost, decrease yield of the crop, harbours insects and plant diseases, decrease quality of farm produce and reduce values of the land. The weed in India are causing substantial losses to agriculture production and the annual losses in terms of money come to the Rs.1650 crores (Joshi, 2002) [2]. In agriculture weed causes more damage compared to insects, pests and diseases but due to hidden loss by weed in crop production, it has not drawn much attention of agriculturists (Rao, 2010) [7]. Wheat is generally infested by both grassy weeds viz., Phalaris minor and Avena species and broad leaf weeds i.e. Chenopodium album, Fumaria parviflora, Melilotus indica, Anagalles arvensis, Lathyrus aphaca and Vicia sativa (Malik et al., 1989) [3]. In wheat, yield losses due to weeds may range from 10 to 82 percent depending upon the density and species of weed, duration of infestation and competing ability of crop plants under different agro-ecological conditions (Rao, 1994) [8].

Day by day, weed control through herbicides is increasing and popularizing among farmers. Because, weed control through manual methods is time consuming and tedious and become very costly due to unavailability of labour in peak period and labour charges are also high due to shifting of agricultural labours to industries for better and assured wages. Wheat is sown at very narrow row spacing. Therefore, cultural methods of weed control could not be performed and manual control becomes unaffordable. Hence, use of herbicides popularized particularly in irrigated wheat crop. The farmers are not aware of proper dose of herbicides, time of application, economics and their persistence in the soil. Several selective herbicides are available in the market, which are treated to be effective for particular crop. The farmers have to make decisions about the selection of right type of herbicides. Several grassy and broadleaf weeds infest wheat causing severe competition for essential nutrient, moisture and space thus reducing wheat yield and also its quality significantly (Singh et al., 1995; Gupta et al., 2011) [9, 11]. Keeping these facts in view, the present investigation was under taken to study the effect of fertility levels and weed management practices on yield and economics of wheat crop (Triticum aestivum L.).

Materials and Methods

A field experiment was conducted during the rabi season of 2018–19 and 2019–20 at Agronomy Research Farm of Acharya Narendra Deva University of Agriculture & Technology, Nandera Nagar (Kumarganj), Ayodhya, Uttar Pradesh. Soil was silty loam in texture having pH 8.30 and 8.20, organic carbon 0.33 and 0.32% and available N, P and K were 137.60 and 136.82; 15.20 and 14.70; and 249.30 and 248.32 kg ha⁻¹ respectively during both the year of experimentation. The treatment comprised of three fertility levels viz.: 100% DRF through inorganic fertilizer, 75% RDF through inorganic + 25% N through FYM and 50% RDF through inorganic + 50% N through FYM and 5 weed control practices viz.: Sulfosulfuron + Metsulfuron @ 30 g a.i. + 4 g a.i. ha⁻¹, Clodinafop + Metsulfuron @ 60 g a.i. + 4 g a.i. ha⁻¹, Mesosulfuron + Iodosulfuron @ 12.2 g a.i. + 2.2 g a.i. ha⁻¹, weed free upto 60 Days and Weedy check. The treatments were replicated three times in a factorial randomized block design with fifteen treatment combinations.

A promising wheat variety PBW-154 was sown on 20 November and 24 November during 2018-19 and 2019-20, respectively. Farmyard manure was applied on the individual plot as per treatments basis after pre-sowing irrigation and before the final preparatory tillage. The experimental crop was uniformly fertilized with 150 kg N, 60 kg P₂O₅ and 40 kg K₂O ha⁻¹ in the form of urea, diammonium phosphate and muriate of potash (MOP), respectively as per treatment basis individually. Half dose of nitrogen, full dose of P₂O₅ and MOP was applied as basal dressing. Remaining half dose of nitrogen was top-dressed in two equal splits at CRI stage and tillering stage to ensure good growth of the crop. First irrigation was given at crown root initial stage after that crop was irrigated 20-25 days interval to avoid any kind of water stress. Herbicides were applied as post emergence i.e. 35 DAS with the help of hand-operated Knapsack sprayer, fitted with flat fan nozzle with 250 liter ha⁻¹ water. First hand weeding was done at 20 and second at 40 DAS.

Results and Discussion

Effect on yield

The yield of a crop depends upon the yield attributes viz., number of effective tillers, spikelets spike⁻¹, grains spike⁻¹, length of spike and test weight (1000 grain weight). Any factor affecting their parameters ultimately affects the biological and economic yield of a crop. Source components may be number of tillers, plant height, leaf area index and dry matter of the plants before anthesis and sink components viz., number of effective tillers², no. of spike m⁻², number of spikelets spike⁻¹, length of spike, no. of grain spike⁻¹ and test weight. Final yield of wheat is the function of no. of spike m⁻², no. of grain spike⁻¹ and test weight. The yield attributing characters (Table-1) viz. number of effective tillers m⁻², number of spikelets ear⁻¹ and 1000-grain weight was significantly influenced by fertility levels except length of spike (cm) and number of grains ear⁻¹ and were increased with increase infertility levels during both the year of experiments. The maximum values of all these characters were observed with 100% RDF – through inorganic fertilizer which was at par with 75% RDF – through inorganic fertilizer + 25% N through FYM except test weight during first year of experiments and superior over 50% RDF – through inorganic fertilizer + 50% N through FYM. This might be due to enhanced tillering, photosynthetic area and increased in sink size due to availability of higher quantity of nitrogen at higher level. A similar research finding was reported by Nehra et al. (2001) [4]. All weed management practices produced significantly higher number of effective tillers m⁻², number of spikelets ear⁻¹, number of grains ear⁻¹ and 1000-grain over weedy check while length of spike was found non-significant but numerically higher with weed management practices over weedy check. Weed free upto 60 days produce maximum values of all these characters being at par with Sulfosulfuron + Metsulfuron @ (30 g a.i. + 4 g a.i. ha⁻¹), - Clodinafop + Metsulfuron @ (60 g a.i. + 4 g a.i. ha⁻¹) and superior over weedy check. The treatment combinations F₁W₄ (100% RDF + weed free upto 60 days) was recorded maximum value of grain yield, straw yield, biological yield (Table-2). Similar findings were reported by Tomar and Vivek (2003) [10].

Effect on economics

The cost of cultivation (Table-3) varied with fertility levels and weed management practices. The maximum cost of cultivation (Rs 38290.00 and 37267.00 ha⁻¹) was recorded with treatment combination F₁W₄ (50% RDF – through
inorganic fertilizer + 50% N through FYM + Weed free upto 60 Days) due to high input cost and minimum cost of cultivation (Rs 33615.00 and 32022.00 ha$^{-1}$) was noted with treatment combination F$_1$W$_3$ (100% RDF – through inorganic fertilizer + Weed free upto 60 days) followed by treatment combination F$_2$W$_3$ which was noted with treatment combination F$_1$W$_3$. Similar findings were reported by Pandey et al. (2006) [5].

Maximum benefit cost ratio (2.05 and 2.45) was obtained with treatment combination F$_3$W$_3$  (100% RDF – through inorganic fertilizer + Sulfosulfuron @ 30 g a.i. ha$^{-1}$ + Metsulfuron @ 4 g a.i. ha$^{-1}$) followed by treatment combination F$_2$W$_4$ (2.04 and 2.44) and minimum benefit cost ratio (0.63 and 0.82) was recorded under the treatment combination F$_3$W$_4$ (50% RDF – through inorganic fertilizer + 50% N through FYM + Weedy check), respectively, during both the years. Similar findings were reported by Gupta et al. (2007).

Table 1: Effect of different treatments on yield contributing characters of the wheat crop

| Treatments | No. of effective tillers (m$^{-2}$) | Length of spike (cm) | Number of spikelets ear$^{-1}$ | Number of grains spike$^{-1}$ | Test weight (g) |
|------------|-----------------------------------|----------------------|------------------------------|-----------------------------|-----------------|
| F$_1$ - 100% RDF – through inorganic fertilizer | 257.20 | 255.22 | 10.30 | 10.50 | 16.16 | 15.96 | 42.60 | 43.46 | 40.21 | 40.98 |
| F$_2$ - 75% RDF – through inorganic fertilizer + 25% N through FYM | 257.56 | 255.02 | 10.10 | 10.30 | 16.12 | 15.84 | 42.40 | 43.26 | 38.30 | 39.07 |
| F$_3$ - 50% RDF – through inorganic fertilizer + 50% N through FYM | 237.24 | 234.90 | 9.90 | 10.10 | 14.80 | 14.60 | 41.92 | 42.70 | 36.68 | 37.44 |
| SEm± | 4.686 | 4.730 | 0.151 | 0.140 | 0.299 | 0.235 | 0.672 | 0.638 | 0.574 | 0.743 |
| CD at 5% | 13.575 | 13.703 | NS | NS | 0.866 | 0.682 | NS | NS | 1.664 | 2.153 |

Table 2: Effect of different treatments on grain, straw, biological yield and harvest index of the wheat crop

| Treatments | Grain yield (q ha$^{-1}$) | Straw yield (q ha$^{-1}$) | Biological yield (q ha$^{-1}$) | Harvest index (%) |
|------------|-------------------------|-------------------------|-----------------------------|------------------|
| F$_1$ - 100% RDF – through inorganic fertilizer | 44.50 | 45.83 | 64.32 | 65.15 | 108.82 | 110.98 | 40.81 | 41.21 |
| F$_2$ - 75% RDF – through inorganic fertilizer + 25% N through FYM | 42.20 | 43.47 | 61.59 | 62.38 | 103.79 | 105.85 | 40.55 | 40.96 |
| F$_3$ - 50% RDF – through inorganic fertilizer + 50% N through FYM | 36.76 | 37.86 | 54.70 | 55.41 | 91.46 | 93.27 | 40.11 | 40.51 |
| SEm± | 0.740 | 0.912 | 0.968 | 1.200 | 2.122 | 1.649 | 0.614 | 0.727 |
| CD at 5% | 2.144 | 2.642 | 2.803 | 3.476 | 6.146 | 4.778 | NS | NS |

Table 3: Effect of different treatments on total cost of cultivation, gross return, net return and net return Re$^{-1}$ (B:C)

| Treatment combinations | Total cost of cultivation (Rs ha$^{-1}$) | Gross return (Rs ha$^{-1}$) | Net return (Rs ha$^{-1}$) | B:C |
|------------------------|-----------------------------------------|---------------------------|--------------------------|-----|
| 2018-19 | 2019-20 | 2018-19 | 2019-20 | 2018-19 | 2019-20 | 2018-19 | 2019-20 | 2018-19 | 2019-20 |
| F$_1$W$_1$ | 34990 | 33397 | 106551 | 115535 | 71561 | 81958 | 2.05 | 2.45 |
| F$_1$W$_2$ | 34927 | 33334 | 99216 | 107424 | 64289 | 74900 | 1.85 | 2.22 |
| F$_1$W$_3$ | 35195 | 33602 | 96204 | 104203 | 61009 | 70061 | 1.74 | 2.10 |
In conclusion, based on two year experiments conducted at Agronomy Research Farm of Acharya Narendra Deva University of Agriculture & Technology, Narendra Nagar (Kumarganj), Ayodhya, U. P. found better results of treatment combinations of F₁W₄ (100% RDF + Weed free upto 60 days) in respect to maximum value of grain yield, straw yield, biological yield, gross returns and net returns during both the years. Higher benefit cost ratio was recorded with the treatment combinations of F₁W₁ (100% RDF + Sulfosulfuron + Metsulfuron @ 30 g a.i. + 4 g a.i. ha⁻¹). Thus, it may be concluded that application of 100% recommended dose of NPK ha⁻¹ with Sulfosulfuron + Metsulfuron @ 30 g a.i. + 4 g a.i. ha⁻¹ as proved most superior to other treatment in respect to higher benefit cost ratio of wheat crop.

|   | F₁W₁ | F₁W₂ | F₁W₃ | F₁W₄ | F₁W₅ |
|---|------|------|------|------|------|
| Yield | 35355 | 36438 | 36663 | 36823 | 35083 |
| Straw | 33762 | 35149 | 35354 | 35774 | 33762 |
| Biological | 107490 | 109226 | 102345 | 103557 | 92061 |
| Grain | 82578 | 64441 | 84300 | 74077 | 69610 |
| Net | 2.04 | 1.76 | 1.51 | 1.05 | 1.62 |
| Gross | 2.44 | 1.70 | 1.81 | 1.33 | 1.95 |

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