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Impact of weed control practices and fertilizer management on the growth and yield of wheat (*Triticum aestivum* L.)

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Abstract
A field experiment was conducted during rabi season of 2023-24 on loamy sand of in the rural area of Kanpur district of Mandhana, located 10 km from Kanpur in Uttar Pradesh to Impact of Weed Control Practices and Fertilizer Management on the Growth and Yield of Wheat (*Triticum aestivum* L.)".The soil was normal in pH of 7.55, electrical conductivity (EC) of 0.23 dSm^{-1}, organic carbon content of 0.40%, and available nutrients including nitrogen (N), phosphorus (P), and potassium (K) at levels of 216.20, 19.16, and 149.48 kg ha^{-1}, respectively. The experiment was laid out during Rabi season of 2023-24. The experiment consisted of 12 treatment combinations (3 Weed control measures, & 4 Fertilizer management) was laid out in Randomized Block Design (RBD) with three replications.

Keywords: Herbicides, wheat, fertilizer

Introduction

Known as the "Staff of life or king of cereals," wheat (*Triticum* spp.) is one of the most significant staple food crops. Wheat stands out among other foods for humans because it is high in protein and carbohydrates. Approximately 757.92 million tonnes of grain were produced in 2017–18 from 218.61 million hectares of wheat planted in 124 countries worldwide. The amount of wheat consumed worldwide is estimated to be 672 million tonnes annually, and this amount is predicted to rise steadily in the years to come. India is the world's second-largest producer of wheat, behind China. According to estimates, the nation will produce a record 291.95 million tonnes of food grains in 2019–20, which is 6.74 million tonnes more than the 285.21 million tonnes produced in 2018–19. However, a government release stated that the production during 2019–20 is higher by 26.20 million tonnes than the average production of foodgrain during the preceding five years (2013–14 to 2017–18). From 13.7 million hectares in 1966–1967 to 31.50 million hectares in 2017–18, more land was planted to wheat. Additionally, during this time, productivity increased from 887 to 3146 kg ha^{-1}, and production increased from 11.4 to 106.21 million tonnes (Anonymous, 2019) [1].

One of the biggest dangers to the production of agricultural crops is weeds. They utilize the nutrients, moisture, and fertility of the soil, shelter insect pests, and compete with crop plants for light and space, which lowers yield. Depending on the weed density, frequency, kind, and intensity of competition for growth/yield components, yield losses ranging from 5% to 100% have been reported in various crops in various areas (Ashiq *et al.*, 2003) [2].

The main weeds found in wheat fields are Cyperus rotundus, Cynodon dactylon, Phalaris minor, Chenopodium album, Anagallis arvensis, Avena fatua, Convolvulus arvensis, Lathyrus aphaca, and so forth. Alone, these weeds reduce wheat yield by 33 percent. In the country's northern regions, one of the most significant cropping systems is rice-wheat. One of the most significant issues with wheat in this cropping system is Phalaris minor, which has been known to cause crop losses of up to 65% in certain cases (Chhokar *et al.*, 2008) [3].

Compared to the current annual consumption level of 14 million tonnes, our nation would require a total of 23 million tonnes of fertilizer.

India has recently started a research project to find ways to use nitrogen more efficiently. However, the areas where chemical fertilizers were applied widely have begun to exhibit declining trends in the fertilizer response to food production. The average fertilizer use efficiency (FUE) decreased from 17.1 kg/kg NPK in 1970–71 to 8.1 kg/kg NPK in 1988–89, and there is a chance that it will drop even lower to 6.5 kg/kg NPK by 2000 AD. However, a portion of this behavior can be linked to the law of diminishing return when fertilizer dosage is increased. This could be because less organic manure biomass is applied than chemical fertilizers, which degrades the properties and health of the soil. Finding new nutrient sources is therefore crucial for improving soil fertility and promoting sustainable agriculture.

Material and methods

A field experiment was conducted during rabi season of 2022-23 on loamy sand of in the rural area of Kanpur district of Mandhana, located 10 km from Kanpur in Uttar Pradesh to Impact of Weed Control Practices and Fertilizer Management on the Growth and Yield of Wheat (*Triticum aestivum* L.).The soil had normal values for pH (7.55), organic carbon content (0.40%), electrical conductivity (EC) of 0.23 dSm^{-1}, and available nutrients (nitrogen (N), phosphorus (P), and potassium (K) at 216.20, 19.16, and 149.48 kg ha^{-1}, respectively. The Rabi season of 2023–2024 is when the experiment was set up.There were three weed control measures and twelve treatment combinations in the experiment. At 30, 60, and 90 DAS, W0 Weedy check and W1 Hand weeding Fertilizer management (W3) Clodinafop-propargyl 0.060 kg/ha & 4 F0Without fertilizer, F11 Data on five plants selected from each plot in a Randomized Block Design (RBD) with three replications were collected for each of the following: 50% NPK (180 kg N+120 kg P2O5+90 kg K_2O_5), F2 100% NPK (120 kg N+80 kg P2O5+60 kg K_2O_5), and F375% NPK (90 kg N+60 kg P2O5+45 kg K_2O_5).

Results and Discussion

Yield attributing

Number of grains per ear

The findings displayed in Table 1 demonstrated that, in the current study, weed control techniques had a major impact on the amount of grain produced per ear. In the current experiment, the maximum (50.03) grains per ear was recorded with hand weeding at 30, 60, and 90 DAS, which was significantly higher than the minimum (44.06) with weedy check and the Clodinafop-propargyl application (47.39).

In the current experiments, the highest number of grains per ear (54.78) was found with 150% NPK, which was significantly higher than the numbers of grains per ear (51.97) and 75% NPK (49.47), while the lowest number of grains per ear (32.43) was found with unfertilized plots.

Number of spikelets per ear:

A review of Table 1's data showed that applying weed control techniques greatly increased the number of spikelets per ear. Hand weeding at 30, 60, and 90 DAS produced the greatest number of spikelets (15.88) per ear, which was significantly higher than Clodinafop-propargyl application (14.68 cm). Weedy check plots produced the fewest spikelets (13.18 cm).

In the current study, the application of fertilizer significantly increased the number of spikeletsper ear. In the current experiment, the maximum fertilizer dosage of 150% NPK produced more spikelets (15.90 cm), followed by 100% NPK (15.19 cm) and 75% NPK (14.39 cm) over no fertilizer.

Length of ear (cm)

The length of the ears significantly improved with the application of weed control techniques. The longest (15.90 cm) ears were produced by hand weeding at 30, 60, and 90 DAS; these ears were significantly longer than those produced by applying Clodinafop-propargyl (14.85 cm). In contrast, the smallest ears—12.47 cm—were observed under weedy check plots.

In the current study, the length of the ear varied significantly depending on the fertilizer application. In the current experiment, the fertilizer applied at a rate of 150% NPK resulted in the longest ear length (16.42 cm), which was followed by rates of 100% NPK (15.55 cm) and 75% NPK (14.84 cm) over no fertilizer.

Grain weight per ear

Table 2 data showed that weed control techniques caused significant variations in grain weight per ear. The highest grain weight was obtained by hand weeding and applying Clodinafop-propargyl, whereas the lowest grain weight was obtained by weedy check. Nonetheless, in the current study, hand-weeded plots at 30, 60, and 90 DAS yielded the highest grain weight. This find support the observations of Singh *et al.* (2006) [5], Verma *et al*. (2014) [6], Singh *et al*. (2018) [4] and Kumar *et al*. (2019) [7].

In the current experiment, a notable difference in seed weight per ear was noted as a result of fertilizer application. The application of 150% NPK resulted in the maximum grain weight (3.53 g/ear), which was noticeably greater than that of 100% NPK (3.36 g/plant) and 75% NPK (3.23 g/ear). However, in the current investigation, the unfertilized control produced the minimum grain weight (2.30 g/ear).

Grain weight (g/plant)

The findings displayed in Table 2 demonstrated that, in the current study, weed control techniques significantly affected the weight of grains per plant. In the current experiment, the maximum grain weight (8.82 g/plant) produced by the hand weeding method at 30, 60, and 90 DAS was significantly higher than the minimum grain weight (6.09 g/plant) produced by the weedy check and the post-anthesis application of Clodinafop-propargyl (7.75 g/plant).

The results show that applying NPK fertilizer greatly increased the amount of grain produced per plant. In the current experiment, the lowest grain weight (5.22 g/plant) was noted with no fertilizer, while the maximum grain weight (9.91 g/plant) was obtained with a fertilizer level of 150% NPK, which was significantly higher than 100% NPK (8.21 g/plant) and 75% NPK (6.88 g/plant).

1000, grain weight (g)

The findings displayed in Table 2 demonstrated how the 1000 grain weight of the current study was considerably affected by the weed control techniques used. While minimum (35.93 g) 1000 seed weight was found under weedy check plots, bolder (39.35 g) seeds were recorded by the hand weeding method of weed control, which was significantly on par with Clodinafop-propargyl (38.73 g) in weed weight.

The results clearly demonstrate that the different fertilizer levels in the current investigation had a significant impact on the 1000 grain weight. Significantly bolder seed (40.74g) was produced at fertilizer level 150% NPK, which was comparable to 100% NPK (39.39 g). But in the experiment, 75% NPK had a noticeably higher 1000 seed weight than the control group (Sharma 2011) [13].

Yield (q/ha)

Table 3 displays the findings of a statistical analysis of the data pertaining to harvest index (%), total biomass yield (q ha^{-1}), grain yield (q ha^{-1}), and straw yield (q ha^{-1}). Grain yield (q ha^{-1})

Grain yield (q ha^{-1})

An examination of the data in Table 3 revealed that the experimentation's wheat grain yield was significantly impacted by weed control techniques. Compared to the application of Clodinafop-propargyl (42.40 q/ha), hand weeding at 30-60 and 90 DAS resulted in a significantly higher grain yield (45.32 q ha^{-1}) while the weedy check plot produced the lowest grain yield (26.36 q/ha) in this experiment. The percentage increase in grain yield resulting from the application of Clodinafop-propargyl over weedy check and hand weeding was 60.85% and 71.92 percent, respectively.

Table 3 makes it evident that the different fertilizer levels considerably raised the wheat grain yield q ha^{-1}. In the current experiment, the highest grain yield (45.22 q ha^{-1}) was observed at higher fertilizer levels (150% NPK), which was significantly higher than at 100% NPK (41.96 q ha^{-1}) and 75% NPK (38.06 q/ha). In the current study, however, the lowest grain yield (26.86 q/ha) was discovered in an unfertilized field. Regarding 75%, 100%, and 150% NPK levels of fertilizer application, the percentage increase in grain yield attributable to increasing fertilizer levels over no fertilizer was 41.71, 56.22, and 68.34 percent similar show Sharma (2016) [12].

Straw yield (q/ha)

Table 3's data on straw yield showed that, in the current investigation, weed control techniques considerably increased straw yield when compared to the weedy check. The use of hand weeding at 30, 60, and 90 DAS resulted in the highest straw yield (56.23 q/ha). The highest straw yield (53.09 q/ha) was also produced by the second-best weedicide, Clodinafop-propargyl, when applied post-anthesis, while the lowest straw yield was produced by weedy check.

Additional information from Table 3 showed that fertilizer levels have a major impact on wheat straw yield. The maximum straw yield (53.59 q/ha) was obtained with a higher dose of fertilizer (150% NPK), which was substantially higher than the yields of other fertilizer levels (51.88 q/ha) and 75% NPK (48.89 q/ha). However, in the current experiment, the minimum straw yield (35.80 q/ha) was recorded in unfertilized plots. Similar finding show Rather and Sharma (2009) [8], Verma *et al*. (2014) [6], Kakraliya *et al*. (2017) [9]. Singh *et al* (2018) [4].

Total Biomass yield (q ha^{-1})

In the current experiment, the application of weed control techniques significantly increased the total biomass. When hand weeding and Clodinafop-propargyl were applied, the overall biomass yield increased significantly and was higher than when the weedy check was used. The maximum biomass yield (101.55 q/ha) from hand weeding was substantially higher than that of Clodinafop-propargyl (95.49 q/ha) among the weed control techniques.

In the current study, a significant impact of fertilizer application on the biomass yield q ha^{-1} was noted. The fertilizer used at a higher dose (150% NPK) resulted in the biomass yield q ha^{-1} that was significantly highest (98.81 q/ha), followed by 100% NPK (93.84 q/ha) and 75% NPK (86.95 q/ha). Nevertheless, during experimentation, the lowest biomass yield (62.66 q/ha) was noted under plots without fertilizer (Kumar 2011& malik 2013) [10, 11].

Harvest index (%)

A review of the information in Table 3 revealed that the harvest index in the current study was unaffected by the use of weed control techniques.

Additionally, table 3's results demonstrated that the harvest index varied significantly depending on the amount of fertilizer applied. A higher harvest index (45.69%) was observed with fertilizer applied at a level of 150% NPK, followed by 100% NPK (44.71%), and the lowest harvest index was observed with the unfertilized control (Kumar 2019 & malik 2013) [7, 11].

Table 1: Number of grains per ear, spikelets per ear and length of ear (cm) of wheat as influenced by weed control and fertilizer management

Treatments	No of grains per ear	No of spikelets per ear	Length of ear (cm)
Weed control methods			
Control	44.06	13.18	12.47
Hand weeding (30,60,90 DAS)	50.03	15.88	15.90
Clodinafop-propargyl 0.06kg/ha	47.39	14.68	14.85
S.Em. ±	0.59	0.18	0.18
CD at 5%	1.74	0.54	0.53
Fertilizer management			
Control	32.43	12.83	10.82
150% NPK	54.78	15.90	16.42
100% NPK	51.97	15.19	15.55
75% NPK	49.47	14.39	14.84
S.Em. ±	0.68	0.21	0.21
CD at 5%	2.01	0.62	0.61

Table 2: Grain wt per ear (g), Grain yield (g/plant) and 1000 grain wt (g) of wheat as influenced by weed control and fertilizer management

Treatments	Grain wt per ear (g)	Grain yield (g/plant)	1000 grain wt (g)
Weed control methods			
Control	2.76	6.09	35.93
Hand weeding (30,60,90 DAS)	3.42	8.82	39.35
Clodinafop-propargyl 0.06kg/ha	3.14	7.75	38.73
S.Em. ±	0.039	0.09	0.46
CD at 5%	0.114	0.27	1.34
Fertilizer management			
Control	2.30	5.22	34.24
150% NPK	3.53	9.91	40.74
100% NPK	3.36	8.21	39.39
75% NPK	3.23	6.88	37.65
S.Em. ±	0.044	0.11	0.53
CD at 5%	0.131	0.31	1.55

Table 3: Seed, straw, total biomass yield and harvest index of wheat as influenced by weed control and fertilizer management

Treatments	Grain yield (q/ha)	Straw weight (q/ha)	Total biomass (q/ha)	Harvest index (%)
Weed control methods				
Control	26.36	33.30	59.66	44.08
Hand weeding (30,60,90 DAS)	45.32	56.23	101.55	44.43
Clodinafop-propargyl 0.06kg/ha	42.40	53.09	95.49	44.25
S.Em. ±	0.44	0.68	1.10	0.59
CD at 5%	1.30	2.00	3.23	N/A
Fertilizer management				
Control	26.86	35.80	62.66	42.85
150% NPK	45.22	53.59	98.81	45.69
100% NPK	41.96	51.88	93.84	44.71
75% NPK	38.06	48.89	86.95	43.75
S.Em. ±	0.51	0.78	1.26	0.68
CD at 5%	1.50	2.31	3.73	2.00

Conclusion

Based on the results of the experiment, it was found that higher growth, yield, and net return were obtained with the application of three hand weedings and Clodinafop – Propargyl 60 g ha^{-1}. Given the cost of cultivation and the potential net profit to farmers, applying a higher dose of fertilizer—150 percent—was found to be superior in terms of growth, grain yield, gross income, and net return. This may be the best course of action. Thus, farmers should apply 150% NPK along with hand weeding and Clodinafop – Propargyl 60 g ha^{-1} to achieve the highest production and profit.

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