Original Research Article

GROWTH, YIELD AND ECONOMICS OF WHEAT (*Triticumaestivum*L.) AS INFLUENCED BY DIFFERENT SEED RATES AND WEED CONTROL METHODS.

ABSTRACT

An experiment was conducted at Shradhay Bhagwati Singh Agriculture Research Farm (Hajipur),Chandra Bhanu Gupta krishiSnatakottar Mahavidyalaya, B.K.T., Lucknow (Uttar Pradesh) duringthe *rabi* season of 2021-22. The experiment consisted of 12 treatmentcombinations comprised of 3 seed rates and 4 weed management practices, tested in factorial randomize block design withthreereplications.Theresultsindicatedthatdifferent seed rates and weed management practices significantly influenced the growth, yield andnutrientuptake ofwheat. The soil ofexperimental site was silty loam soils having medium organic carbon (0.70%) and nitrogen (270kg ha^{-1}), phosphorus (27 kg ha^{-1}) and potassium (262 kg ha^{-1}). Crop sown with seed rate,S_3(120 kg ha^{-1}) recorded highest plant height, number of tillersm^{-2}, leaf area index, dry matter accumulation, number of effective tillers, grain yield, straw yield, biological yield and nutrient uptake. However, higher number of grains $spike^{-1}$, grain weight $spike^{-1}$, length of spike and test weight was recorded with crop sown with 100 kg ha^{-1} seed rate. Weed free upto 60 DAS (W_1) resulted in significantly higher growth and yield attributes and yields over rest of the weed control treatment. Post emergence spray of Clodinafop + Metsulfuron (60 + 4) g ha^{-1} recorded significantly higher values of all growth, yield attributes and yield over sulfosulfuron @ 25g *a.i*ha^{-1}. Weed free upto 60 DAS had highest weed control efficiency followed by Clodinafop + Metsulfuron 60 + 4 g ha^{-1} (49.78%). However, the highest weed index was noticed in weedy check and lowest with herbicide mixture. The highest net returns (Rs. 69036) and B:C (1.73) were obtained with combination of 120 kg seed rate ha^{-1} + Clodinafop+ Metsulfuron @60g ha^{-1} +4g ha^{-1} (PoE) at 30-35 DAS.

Keywords: Seed rate,weed control ,growth,yield,economics andwheat.

1. INTRODUCTION

Wheat (*Triticum aestivum*L.) the world's largest cereal crop belongs to Poaceae (Gramineae) familyof the genus *Triticum.* Wheat is the most important second staple food crop after rice and widelycultivated in world. It is cultivated in almost all countries; the major wheat producing countries areChina, India, USA, Russia, France, Canada, Germany and Australia. India stands second positionnextto Chinain theworld with regard to area andproduction ofwheatcrop.

India accounts for 13.43 per cent of global wheat area (29.55 million ha), 12.96 per cent ofglobal wheat production (101.29 million tonnes) and is the second largest producer of wheat afterChina**.** The major wheat producing states in India are Uttar Pradesh, Punjab, and Haryana with theproduction of 28.5, 15.73 and 11.23 million tons, respectively. The Uttar Pradesh ranked first inpercentageshareofwheatproduction(35.39%)followedbyPunjab(19.80%)andHaryana(13.45%). In Uttar Pradesh, wheat is grown on 9.65 m ha area with total production of 33 milliontons and average productivity of 3177 kg ha^{-1}(Anonymous, 2020) which is considered to be low as compared toPunjab(4911kg ha^{-1})andHaryana(4590kg ha^{-1}).Fertilizersplayedavitalroleinagriculture production and productivity in India. One of the major causes of wheat's low productivity, among other aspects, is weed management and seed rate.

100 kg ha^{-1}seed rate is required for typical sowing conditions (Prasad, 2012). Planting density has a significant impact on wheat output and quality. When wheat is planted late, it struggles to germinate and doesn't have the ideal population $unit^{-1}$ area. Late wheat planting tends to reduce the number of germinations and tillers $unit^{-1}$ area due to a significant rise in temperature during the crop's tillering period, thus reducing production (Soomro *et al.,* 2002).Higher seed rate is important for increasing wheat production potential because it compensates the poor tillering caused by the cold temperatures **(**Singh *et al.,* 1993).

One of the best ways to increase the yield had been seen as increasing plant densities through increasing seed rates.Due to the varying seed sizes, sowing schedules, and sowing techniques used in various regions, the seed rate employed in different parts of India for wheat crop varies significantly, ranging from 80 to 150 kg ha^{-1}. To ensure an optimum and productive plant population for standard yields under late sown wheat, a substantially greater seed rate is

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recommended. Therefore, it is possible that a greater seed rate will result in more tillers unit^{-1} area and a better grain yield for crops by suppressing the growth of weeds.

One of the main problems faced by farmers in their effort for a greater yield is the infestation of several weed species in wheat. A substantial infestation of grassy and wide leaf weeds in the wheat crop is also caused by the initial high soil moisture and open space. Little seed canary grass (*Phalaris minor*) is a very persistent weed species in wheat. There has been a considerable decrease in wheat production ranging from 18 to 73 % as a result of a severe weed infestation. In India, weeds significantly reduce agriculture productivity; the yearly financial losses are over Rs. 1650 crores **(**Joshi, 2002)**.** Weed control during the early stages of wheat crop growth is important because a heavy weed infestation slows crop growth and results in a lower wheat yield. The common weeds found in wheat fields are *Phalaris minor, Cyperus rotundus, Cynodondactylon, Chenopodium album, Anagallis arvensis, Avena fatua, Convolvulus arvensis,* and other species. Such weeds alone decrease wheat yield by 33%. The farmers do not know the right quantity of herbicides to use, when to apply them, how much they cost, or how long they last in the soil. There are a variety of selective herbicides available that have been developed to function well with a specific plant. Farmers must decide which type of herbicide is most effective.

There are numerous alternatives, including manual weeding and herbicide treatment, for the effective management of weeds applied at time of sowing and throughout the subsequent crop growth stages. Clodinafop is specific to *Phalaris minor* and *A. ludoviciana* but is ineffective against broad-leaved weeds. A successive application of Clodinafop+Metsulfuron or Sulfosulfuron at 30-35 DAS was successful in resolving the issue of complex weed flora in wheat. The combination of metsulfuron and sulfosulfuron had the best weed control efficacy (91.5%) of all herbicidal treatments. Metsulfuron + sulfosulfuron, followed by metsulfuron + isoproturon, 2, 4-D + isoproturon, and 2,4-D + sulfosulfuron, significantly increased grain production **(**Khokhar *et al.,* 2010**).**

2. MATERIALS AND METHODS

A field experiment was conduct at Shradhay Bhagwati Singh Agriculture Research Farm (Hajipur),Chandra Bhanu Gupta Krishi Snatkottar Mahavidyalaya, Bakshi-Ka-Talab, Lucknow University,Lucknow (U.P.) during *rabi* season of 2021-2022. The experimental site is situated at 26.50º Northlatitude and 80.50º East longitude with an altitude of 123 meters above mean sea level. The soil ofexperimental field was silty-loam texture, slightly alkaline in reaction (8.00 pH), medium in organiccarbon(0.70%)andavailable nitrogen(270 kg ha^{-1}) phosphorus(27 kg ha^{-1}) andpotassium(262kg ha^{-1}). Twelvetreatmentscomprisedofthreeseed rate (100, 110 and 120 kg ha^{-1}) andfour weed control methods (Weed free upto 60 DAS, Sulfosulfuron@25g.*a.i*/ha at 30-35 DAS, Clodinafop + metsulfuron @ 60g/ha + 4g/ha at 30-35 DAS and Weedy check till maturity) werelaidoutin factorial randomize block design with three replications. The wheatvariety(PBW-502)wassown lastweekof November 2022, at 20 cm apart rows and harvested in second week of April 2022. Allimproved packages of practices were followed to raise the crop. The data on plant height at harvest and tillers at harvestwere recorded from the area already marked by tagged. Sample for dry matter accumulation at harvest wasrecorded by cutting of plants 25 cm row length. The fresh samples were first sun dried and then keptin electric oven at 65-70ºC till the constant dry weight attained. Yield attributes (Effective tillers m^{-2} at harvest,Lengthofspike(cm) at harvest, Number of grains spike^{-1} at harvest, Grainweight(g) spike^{-1} at harvest and Testweight(g)) were recorded from10spikesselectedrandomlyfromeachplot.Grainandstrawyieldsofwheatwererecordedatharvest.Theharvestindexwascalculatedasgrainyielddividedbytotalbiologicalyieldandmultiplied by hundred. The uptake of nutrients was calculated as:

$$Uptake\ of\ nutrient\ (kg/ha) = (\text{Nutrient content}\ (\%) \times Yield\ (kg/ha))/100$$

Economics of different treatments was worked out on the basis ofprevailing market prices. The data so obtained on various parameters were analysed as per standardstatistical procedures. The content of N, P, and K in grain and straw was determined by using standardlaboratoryprocedures like Kjeldahl method (N), Colorimetric method (P) and Di-acid method with flame photometer.

3. RESULTSANDDISCUSSION

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3.1 Growthattributes

Plant height, number of tillers, leaf area index and dry matter accumulation of wheat were affectedsignificantly due to application of different seed rates and weed control techniques. Increasing seed rate up to 120 kg seeds ha^{-1} increased the plant height, number of tillers, leaf area and dry matteraccumulation significantly over rest of the seed rates. The maximum plant height (93.26 cm),leafareaindex(4.81),numberoftillers(376.08m^{-2})anddrymatteraccumulation(1204.94g m^{-2})was recorded significantly with 120 kg seed rate ha^{-1} over rest of seed rate but being at par with 100 kgseed rate ha^{-1}. Significant improvement in growth parameters might be due to increasing seed rate led to an increased number of plants and increased number of tillers and this led to light interception and thereby increase in the efficiency of photosynthesis and translocation of photosynthetes to plant increased the growth attributes.Theseresults aresupported by the findings of**(**Rajesh*et al.,* 2018)**,(**Hussain *et al.,* 2010).

Different weed management practice affected the growth attributes statistically. Weed free upto 60 DAS recorded significantly tallerplant, higher tillers, leaf area index and dry matter accumulation as compared to other weed control measures. The highest plant height (91.79 cm), leaf area index (4.9), number of tillers (373.88 m^{-2}) and dry matter(1301.68 g m^{-2})was recorded with the weed free upto 60 DAS. It might be due to lesser crop – weed competition for space, light and moisture which improved the uptake of nutrient to crop. Similar results were obtainedby**(**Malik *et al.,* 2013)**, (**Singh *et al.,* 2012)**.**

3.2 Yieldattributes

Yieldattributingcharacterslikeeffectivetillers m^{-2},spike length(cm),number ofgrains $spikes^{-1}$,grain weight (g) and test weight (g) were affected significantly due to different seed rate and weed control measures. The number of efficient tillers dramatically increased with seed rates 120 kg ha^{-1}. The higher number of effective tillers with higher seed rate could be attributed to lesser intra and inter plant competition which leads to higher availability of space, moisture, nutrients and light to crop leads to higher number of tillers. With an increase in seed rates, the length of the spike (cm), number of grains $spike^{-1}$, grain weight $spike^{-1}$, and test weight (g) all significantly decreased. The treatment with 100 kg ha^{-1} seed rate recorded a significantly higher length of spike (11.75 cm), number of grains $spike^{-1}$ (41.20), grain weight (1.48 g) and test weight (40.18 g). Theseresults aresupported by the findings of**(**Singh *et al.,* 2013)**, (**Behzad *et al.,* 2020)**.**

Among weed management practices, weed-free upto 60 DAS recorded higher number of effective tillers (358.33), grain $spike^{-1}$ (41.30), length of spikes (10.55), grain weight $spike^{-1}$ (1.47), and test weight (40.42g). Higher yield attributes were recorded with weed free upto 60DAS might be due to less crop-weed competition, allowing the crop to utilize inputs most effectively for the creation and development of yield qualities, leading to the greatest spike m^{-2}, spike length, number of grains $spike^{-1}$, and spike test weight. Theseresults aresupported by the findings of (Singh *et al.,* 2012), (Kumar *et al.,* 2018)**.**

Table1. Growthattributesofwheatasaffectedbydifferent seed rate and weed management practices				
Treatments	Plantheight(cm) at harvest	Number oftillers m^{-2} at harvest	Leafareaindex at 90 DAS	Drymatteraccumulation(gm^{-2}) at harvest

Seed rate (kg ha^{-1})				
S_1-100	84.53	337.50	3.93	1141.66
S_2-110	91.23	356.83	4.20	1182.15
S_3-120	93.26	376.08	4.81	1204.94
SEm±	0.37	0.91	0.04	15.40
CDat5%	1.09	2.71	0.12	45.47
Weed management practices				
W_1-Weed free upto 60 DAS	91.79	366.77	4.99	1301.68
W_2-Sulfosulfuron@25 g *a.i.* ha^{-1} at 30-35DAS	88.71	353.44	4.64	1212.07
W_3-Clodinafop + metsulfuron @ 60g ha^{-1} + 4g ha^{-1} at 30-35(DAS)	90.54	359.00	4.82	1260.62
W_4-Weedy check till maturity	87.67	348.00	2.80	1122.05
SEm±	0.94	8.35	0.25	5.36
CDat5%	2.83	25.05	0.76	15.84
Interaction				
SEm±	1.26	9.11	0.24	18.54
CDat5%	-	-	-	-

Table2. YieldattributingcharactersandyieldsofWheatasaffected bydifferent seed rate and weed management practices

Treatments	Effectivetillers m^{-2} at harvest	Lengthofspike(cm) at harvest	No. ofgrainspike^{-1} at harvest	Grainweight(g) spike^{-1} at harvest	Test weight(g)	Grainyield(q ha^{-1})	Strawyield(q ha^{-1})
Seed rate (kg ha^{-1})							
S_1-100	331.33	11.75	41.20	1.48	40.18	38.26	45.90
S_2-110	348.00	9.79	37.27	1.36	38.92	41.52	46.40
S_3-120	358.91	7.85	35.56	1.28	38.11	42.19	47.74
SEm±	2.82	0.08	0.27	0.008	0.15	0.22	0.25
CDat5%	8.33	0.24	0.79	0.02	0.46	0.65	0.75
Weed management Practices							
W_1-Weed free upto 60 DAS	358.33	10.55	41.30	1.47	40.42	42.18	48.45
W_2-Sulfosulfuron@25g *a.i.*ha^{-1} at 30-35 DAS	343.66	9.68	37.82	1.37	38.75	40.34	46.32
W_3-Clodinafop + metsulfuron @ 60g ha^{-1} + 4g ha^{-1} at 30-35(DAS)	349.00	10.08	39.32	1.41	39.36	41.15	47.25
W_4-Weedy check till maturity	333.33	8.87	33.63	1.24	37.75	38.94	44.71
SEm±	3.26	0.09	0.31	0.009	0.18	0.25	0.29
CDat5%	9.62	0.28	0.92	0.02	0.53	0.44	0.86
Interaction							
SEm±	5.82	0.15	0.48	0.015	0.28	0.43	0.49
CDat5%	-	-	-	-	-	-	-

3.3 Yield studies

Due to seed rate, there was a significant variation in wheat yields. With an increase in seed rates from 100 to 120 kg ha^{-1}, the yields of grains, straw, and biological products increased significantly. The highest grain yield, straw yield, and biological yield were recorded under 120 kg ha^{-1} (42.19 q ha^{-1}, 47.74 q ha^{-1}, and 92.80 q ha^{-1}), which was significantly higher than 110 kg ha^{-1} (41.52 q ha^{-1}, 46.40 q ha^{-1}, and 89.30 q ha^{-1}), and 100 kg ha^{-1} (38.26 q ha^{-1}, 45.90 q ha^{-1}, and 80.32 q ha^{-1}, respectively. This might be due to increased seed rates increased the number of plants $unit^{-1}$ area, which in turn raised the number of spikes, and enhanced yield. Theseresults aresupported by the findings of (Ramdhan, 2013)**.**

Different weed control methods statistically affected grain yield. In comparison to weedy check, all weed management methods had a considerably greater grain yield. Maximum grain and straw yields of 42.18 q ha^{-1} and 48.45 q ha^{-1}, respectively, were obtained in weed-free fields up to 60 DAS. The greater yield in weed free conditions up to 60 DAS was caused by little crop-weed competition for light, nutrients, space, and moisture, which increased the availability of nutrients and improved their absorption, which in turn improved the development and synthesis of higher photosynthetes, which in turn improved yield characteristics and, therefore, the grain and straw yield increased under weed free conditions and herbicide mixture. However, heavy crop-weed competition under weedy check reduced the growth and yield attributes and grain and straw yield accordingly. Theseresults aresupported by the findings of (Kumar *et al.,* 2018)**.**

3.4 Nutrientuptake

The uptake of N, P and K by wheat was also significantly affected by the different seed rates. Increasing seed rate increased the uptake of N, P and K in grain and straw significantly. Crop sown with 120 kg ha^{-1} recorded significantly highest uptake of N(77.92 kg ha^{-1}), P(31.28 kg ha^{-1}) and K(18.99 kg ha^{-1}) in grain and (6.55 kg ha^{-1}), (26.73 kg ha^{-1}) and (82.45 kg ha^{-1}) in straw respectively over other seed rates. Nitrogen, phosphorus and potassium uptake by crop was significantly influenced by application of various weed control measures. The highest N, P and K uptake in grain (79.33 kg ha^{-1}, 27.77 kg $ha^{-1}$and 17.68 kg ha^{-1}respectively) and straw (6.56 kg ha^{-1}, 21.48 kg $ha^{-1}$and 76.00 kg ha^{-1}) was recorded in weed free condition and lowest in weedy check. Theseresults aresupported by the findings of (Kumar*et al.,*2021), **(**Azad *et al.,*2008)**, (**Iqbal *et al.,* 2012)**.**

3.5 Economics

Crop sown with 120 kg ha^{-1}seed rate + weed free upto 60 DAS gave the highest gross income (Rs 111025 ha^{-1}) followed by 110 kg ha^{-1}seed rate + weed free upto 60 DAS (Rs 110541 ha^{-1}) and 120 kg ha^{-1}seed rate + Clodinafop @ 60 a.i g ha^{-1}+ Metsulfuron @ 4 a.i g ha^{-1} (Rs 108815 ha^{-1}). Crop sown with 120 kg ha^{-1}seed rate + Clodinafop @ 60 a.i g ha^{-1}+ Metsulfuron @ 4 a.i g ha^{-1} recorded the highest net return (Rs. 69036 ha^{-1}) and benefit cost ratio (1.73). Weedy check gave the lowest gross income, net income and BCR at all seed rates and weed management practices. The high net income and benefit cost ratio with 120 kg ha^{-1}seed rate + Clodinafop @ 60 a.i g ha^{-1}+ Metsulfuron @ 4 a.i g ha^{-1} was due to higher increase in grain and straw yield proportionally lower cost of cultivation involved in this treatment. Lower profit and BCR with weedy check was due to lowest yield and proportionally high cost.

4. Conclusion

Post emergence spray of clodinafop + metsulfuron @ (60 + 4) g ha^{-1} and seed rate of 120 kg ha^{-1} should be adopted for obtaining effective control of weed, net income and benefit cost ratio under late sown condition.

Table 3. Nutrient uptake (kg/ha) in wheat as affected by seed rate and weed management practices						
Treatments	**Nutrientuptake(kg/ha)**					
	Grain			**Straw**		
	N	**P**	**K**	**N**	**P**	**K**
SEED RATE (kg/ha)						
S_1-100	63.18	19.83	13.35	4.67	15.24	59.62
S_2-110	72.91	26.90	17.33	6.32	20.88	73.15
S_3-120	77.92	31.28	18.99	6.55	26.73	82.45
SEm±	0.35	0.20	0.21	0.16	0.17	0.57
C.Dat5%	1.03	0.59	0.64	0.49	0.52	1.70
WEED MANAGEMENT PRACTICES						
W_1-Weed free upto 60 DAS	79.33	27.77	17.68	6.56	21.48	76.00
W_2-Sulfosulfuron@25g.*a.i*/ha at 30- 35 DAS	70.09	25.26	16.16	5.57	20.75	71.44
W_3-Clodinafop+metsulfuron @60g/ha + 4g/ha at 30-35(DAS)	72.19	27.12	16.99	6.38	20.89	73.44
W_4-Weedy check till maturity	63.75	23.86	15.40	4.87	19.69	66.08
SEm±	0.40	0.20	0.21	0.19	0.20	0.66
C.Dat5%	2.07	0.68	0.74	0.57	0.60	1.96
Interaction						
SEm±	0.69	0.37	0.38	0.32	0.33	1.12
CDat5%	-	-	-	-	-	-

Table 4.Economics as affected by different seed rate and weed management practices		
S.No.	**Treatments**	**B:C Ratio**
1.	S1W1	1.20
2.	S1W2	1.47
3.	S1W3	1.57
4.	S1W4	1.43
5.	S2W1	1.32
6.	S2W2	1.65
7.	S2W3	1.72
8.	S2W4	1.65
9.	S3W1	1.32
10.	S3W2	1.65
11.	S3W3	1.73
12.	S3W4	1.64

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